Canada Alberta

FOREST RESOURCE DEVELOPMENT AGREEMENT
ENTENTE SUR LA MISE EN VALEUR DES RESSOURCES FORESTIERES

Canada

Alberta

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The Canada-Alberta Forest Resource Development Agreement is a subsidiary agreement of the Canada-Alberta Economic and Regional Development Agreement, which provides coordination and cooperation between the governments of Alberta and Canada in areas of Alberta's economic development.

The Canada-Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by the Canadian Forestry Service and the Alberta Forest Service.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est auxiliaire à l'Entente Canada-Alberta sur le développement économique et régional, qui vise à assurer la coordination et la coopération des deux gouvernements relativement au développement économique de l'Alberta.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par le Service canadien des forêts et le Service forestier de l'Alberta.

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MARKET STUDY
FOR
CEMENT/GYPSUM BONDED PARTICLEBOARD

Final Report

by
D.G. Bell & Associates Inc. [1]

This is a joint publication of the Canadian
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DISCLAIMER

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EXECUTIVE SUMMARY

CBPB has emerged as a specialty board product for applications where strength and fire protection are important.

The product has gained greatest market acceptance in the Soviet Union

Imported product from Belgium and Mexico is sold in the U.S. A small amount of Belgian product has been sold here in Canada.

Cement bonded particleboard has made small market inroads in Europe for specialized usage areas including roof decking, partitioning, external cladding, tunnel lining, fire resistant doors, etc. Market acceptance has been greater in some third world countries where resins for wood bonded product are difficult to obtain. The product has gained acceptance in the Soviet Union, where seven plants are operating. Both Bison-Werke and Siemplkamp are very active in the development of this market and have systems that produce not only panels but complete prefabricated structures. To date Bison has constructed 25-26 cement particleboard mills throughout the world. The only one operational in North America is located in Mexico. Cement bonded products have provided an alternative to a variety of exterior claddings for buildings, and have been used to a large degree as a substitute for asbestos based cement products. In North America the only cement boards that have been sold to date, apart from asbestos based products, are those that are poured or those that are imported. A Texas company is trying to distribute the Mexican board. The Eternit Corporation distributes its Belgian produced product in the United States through G.H. Corporation in Reading, Pennsylvania. The market usage

The North American end user market has very limited knowledge of CBPB

The prime reason for the limited product development appears to be "price."

The major opportunity for CBPB would be as a replacement for Asbestos Cement boards.

for these cement board products is limited and end users of board products here in Canada and in the United States generally have little or no knowledge of these items. The reason for the low level of interest by manufacturers and end users is the price of these products compared to less expensive substitutes. The major market opportunities for these products in North America appear to be industrial roofing and exterior wall cladding, where strength and fire resistance is important. The product, if properly developed, could be a replacement for asbestos cement. Raw materials are available for both types of cement board products here in Canada. The weight of the products makes these items difficult to handle and costly to transport, however, as a percentage of total value of each board, transportation does not appear to be of great significance.

GBPB is a brand new product from Finland and Norway, offered as a substitute for drywall and particleboard.

Gypsum bonded particleboard is a new product that has only been on the market for 2 years. Produced in Finland and Norway much of the product is shipped to the Soviet Union and a small amount is being offered as a substitute for particleboard in the West German furniture trade. The process uses round wood chips and synthetic gypsum which has been calcined, sourced (in Finland) from a nearby phosphoric acid plant. The

GBPB is sold primarily in Finland, Norway and the Soviet Union and has little distribution anywhere else at present.

product has not made any significant market inroads in Europe to our knowledge and is not for sale in the U.K. The product advantages over regular drywall appear to be its strength, the possibility of mechanical treatment, and its density for flooring and sound proofing. The disadvantages are its weight and its higher cost. The market opportunity for the product in Europe has been reviewed by many of the cement companies and gypsum product producers. The general conclusion is that the product has limited specialized application as compared to standard drywall or particleboard.

GBPB is also a board for specialized application.

The opportunities for development of this product here in Canada appear limited to specialty interior wall usage in a market where present gypsum drywall commands the bulk of the market. There may also be a small opportunity as a substitute for particleboard in the furniture market where fire resistance is required.

Both CBPB & GBPB offer advantages in particular market niches but neither product is a major replacement for high volume board products.

The board market here in North America is dominated by presently accepted panels and none of them have enough disadvantages for users to consider a replacement product with the exception of the asbestos cement items. The gypsum flake board product is too new on the market to be classed as a proven production item and the market acceptance of it has yet to be established.

Future development on these boards is likely to come from companies with experience in cement and/or gypsum.

In our opinion future development for cement or gypsum based particleboards will be directed at specialized market sectors and spearheaded by those companies who already produce cement and gypsum based products and who have the research facilities capable of developing these items.

A test market using imported boards would be a logical step, if further action is to be considered.

As a policy, the Corporation should continue to monitor the activities of the board business to be aware of competitive products. However, if company management believe that further serious evaluation should be given to either of these board items in the short term, our conclusion is that a test market should be developed in Canada utilizing imported board product.

PHASE I

THE MARKETS FOR BOARD PRODUCTS IN NORTH AMERICA

The following section provides an overview of markets by volume here in Canada and in the United States for board products in general.

Because of the size of these markets, the issues that this report will ultimately address will not relate to overall volumes but to the potential specific segments or market "niches" that may provide an opportunity for a new gypsum board or cement board operation here in this country.

Obviously the following charts demonstrate that market size is not a concern. What will affect future sales is product advantages, product costs, and some of the potential negative product attributes that may impact on the sales of CBPB and GBPB.

EXHIBIT II

STRUCTURAL PANEL CONSUMPTION IN CANADA

1MM SQ. FT. - 3/8 BASIS

Year	Construction Plywood	Wafer Board	Particle Board*	Insulation Board	Total
1982	2,338	493	62	316	3,209
1983	3,453	697	102	392	4,644
1984	3,964	911	110	488	5,473
1985	3,847	1087	112	482	5,528
1986	3,610	1122	106	463	5,301

* Particleboard that is used in construction

SOURCE: Selected Forestry Statistics Canada 1986
Canadian Forest Service & D.G. Bell Estimates

SUMMARY OF TRENDS IN THE BOARD INDUSTRY IN NORTH AMERICA

Using analyses of historical trends, the predictions for the use of wood products particularly wood and structural panels over the next two decades are quite positive especially in the construction of single family housing here in Canada and in the United States. Whereas plywood has dominated the major usage areas such as roofing, wall sheathing, floor decking and exterior siding some significant in-roads are being made by other products such as waferboard, OSB, gypsum board and some types of aluminum and plastic sheathing where high insulation values have been created.

It is likely that competition from the lower cost boards is going to continue to remain strong and just as plywood replaced lumber in the 50's, now waferboard and OSB will continue to replace plywood. The fact that the American Plywood Association has now recognized waferboard and OSB as reliable construction materials is another factor that supports this trend. New oriented strandboard mills are being announced on a regular basis now.

The use of wood products for exterior siding is increasing, particularly in the United States, It is a good competitive alternative to the higher cost of brick and it is popular because of its natural appearance.

Most of the long range surveys that have been developed for the next 15 to 20 years indicate structural panels increasing in use. Conversly, some of the new building systems that use plastics, metals or cement products with non-historic designs, have in general been less than successful. Whether there is an opportunity for a cement board product to make in-roads into this marketplace remains to be assessed.

CURRENT DEVELOPMENT OF CEMENT AND GYPSUM PARTICLEBOARDS

The two basic products under consideration here are cement particleboard and gypsum particleboard. In the following pages we have provided an overview of the current development for each of these products in other parts of the world.

Gypsum Particleboard

The Product

Gypsum bonded particleboard is a semi-dry process where water from within the wood particles is used to set the gypsum binder. This process was developed several years ago in the W.K.I. Research labs and the rights have been acquired by Bison-Werke. The first operational plant is located in Finland.

The amount of gypsum can be varied to achieve the desired end result but 25% to 30% by weight appears to be optimum. It is claimed that a strong uniform product can be molded in roughly 3 hours of curing time with proper control of moisture.

When placed in a high moisture environment, the swelling for typical gypsum particleboard is less than 2%. Comments made by market assessors in Europe as well as government representatives here in Canada, have estimated the cost of producing these panels to be roughly 15% less than for regular furniture grade particleboard. The manufacturing process allows thick panels to be made without significant cost increases because the process is cold setting. The product is fire resistant and can be handled in a manner similar to traditional paper covered gypsum board.

W.K.I. developed the original patent on gypsum particleboard and is now preparing reports on the properties of the product and assisting in the development of statistics to support new product applications. Particular work is being done on the development relative to accelerators and retarders that can control the cure time.

The process for producing gypsum flakeboard is proven although in its infancy. The product can be used in humid conditions, is more fire resistant than conventional wall board and is relatively easy to produce using conventional particleboard and cement board manufacturing equipment. Of the two basic materials (gypsum and wood), wood give strength and gypsum gives incombustibility and mineralic character.

Comparing gypsum flakeboard with wallboard, fiberboard and particleboard provides the following information.

Gypsum flakeboard appears to be superior in compressive strength to all other building boards as shown in Exhibit III. This could provide an opportunity for application as flooring.

Comparing gypsum flakeboard to plasterboard provides the following advantages and disadvantages.

Advantages

- possible jointless assembly without tapes
- mechanical strength
- possible surface treatment with veneers
- production of thick panels for greater sound and higher fire rating
- thick panels for flooring
- better sound rating due to high density

Disadvantages

- high density or weight
- lack of trade knowledge on construction techniques

A cost comparison of gypsum flakeboard to particleboard is presented in Exhibit IV. Note that the FOB plant cost is purported to be less than that of wall board. Bearing in mind the raw material costs and the slow speed of the mill, we question the conclusions drawn by these figures.

EXHIBIT III

COMPARISON OF GYPSUM FLAKEBOARD PHYSICAL PROPERTIES WITH OTHER BUILDING BOARDS

Property	Unit	Gypsum Board (flake reinforced)			Gypsum Cardboard (glass fiber reinforced)			Gypsum Cardboard (normal)			Gypsum Fiber Board	Particleboard for Building Purposes
Specific Weight	lb/ft^3	62.4	68.7	74.9	⊥	53.1	∥	⊥	53.1	∥	71.8	43.7
Modulus of Rupture (DIN 52362)	psi	850	1065-1135	1207-1278	425		850-995	355		710-850	780	2556
Modulus of Elasticity	psi x 10^3	426-497	568-596	639-710	412		326	355		284	412-426	426
Linear Expansion From 68°F/30 To 68°F/85	%	0.06	0.05	0.05		0.03			0.03		0.03-0.05	0.35
Surface Strength (DIN 52366)	psi	35.0	40	50		34			34		31	114-142
Impact Strength according to BS 5669	in.	3.9	4.3	4.9		3			2.4		4.3	11.8
Interior Bond (DIN 52365)	psi	38.5	42.6	56.8		34.1			32.7		28.4	80.0
Swelling (2 hr) (DIN 52364)	%	2.6	2.5	2.5		3			3		3	8
Screw Extraction		1410	1690	1690∥		minimum			minimum		1130	1690-2260
Resistance 4/40 mm	lb/in.	3670	3950	$3950_{\perp}$		450-560			340-350		2260	3380-5080
Nailability			+			-			-		(+)	+
Smooth Surfaces			2+			-			-		1+	2+
Sanding Ability			+			-			-		+ one side	+
Thickness (unsanded)	in.		0.024±			±0.020 (0.031)			−0.020		±0.031	±0.020
Tolerance (sanded)	in.		±0.006			-			-		±0.008	±0.005

SOURCE: Abstract: Hubner, 1986, WSU

EXHIBIT IV
COST COMPARISON BETWEEN WALLBOARD & GYPSUM FLAKEBOARD*

	UNIT	WALLBOARD	GYPSUM FLAKEBOARD
Thickness	in.	1/2	3/8
	mm	12.7	9.5
Weight of 1000 ft^2	lb	up to 1000**	970**
RAW MATERIALS			
Stucco	lb	1,700	about 1,500
Flakes (bone dry)	lb		about 350
Paper	lb	80-110	
Chemicals	lb	25-35	1-2
Water added	lb	1,200***	about 500***
ENERGY			
Thermal energy	10^6kJ	2	0.6
Electrical energy	kWh	40	100
LABOUR			
Working minutes	min	35	35
Overheads/administration	min	20-30	20-30
CAPITAL COST			
Weight of equipment	10^6lb	1-1.2	2.0-2.2
Depreciation 70,000 hours	$/1000 ft. (U.S. funds)	9-10	13-14
Interest (10%)	$/1000 ft. (U.S. funds)	4.5-5	6.5-7****
MISCELLANEOUS			
Maintenance, etc.	$/1000 ft (U.S. funds)	3	3.4
ESTIMATED SUBTOTAL			
FOB plant	$/1000 ft. (U.S. funds)	100-110	95-105

* Plant capacity (small) - 250 sheets/hours

Base: $\dfrac{\text{100 sq. ft.}}{\text{without calcination}}$ (93 m^2)

** = adjustable
*** = due to moisture
**** = on half investment
SOURCE: Abstract: J.E. Hubner - Bison-Werke

Advantages and disadvantages of gypsum flakeboard over particleboard are summarized as follows:

Advantages

- better fire rating
- better sound rating
- small linear expansion
- easy to repair
- no formaldehyde
- lower production costs*

* to be confirmed

Disadvantages

- weight of the product
- limited mechanical edge treatment
- lack of knowledge or ability to use product

Appendix I provides an outline of the technological process used in the development of this product as presented by a representative of Bison-Werke in West Germany.

The Manufacturers

Gypsum bonded particle board is a new product in the marketplace. The first plant to produce this new type of panel is located in Kuopio about 250 miles north of Helsinki in Finland. This plant was opened in October 1985 and produces a capacity of roughly 45,000 tons a year. The raw materials are local wood flakes and waste gypsum from a nearby phosphoric acid plant. The wood source is debarked spruce and alder round wood. This plant was constructed by Bison-Werke. A second plant (with 60,000 ton per year capacity) was due for completion in late 1987 in Norway.

At the present time to our knowledge, these are the only two gypsum flakeboard plants that are operational. Rauma-Repola is interested in the product and is working with an engineering consulting group in Japan to develop production technology and equipment.

Any of the other gypsum based boards that are produced around the world other than the basic plaster board, are assembled using a fiber process from waste paper.

Appendix II contains some basic information and data on the construction of a board plant.

Regarding the machinery that is provided by a company such as Bison-Werke, conventional particleboard and cement-bonded board manufacturing equipment is being modified to produce this new board product.

The plant design that is suggested by Bison-Werke allows for small and medium sized capacities and they suggest placing the plant relatively close to the marketplace in order to control high transportation costs. In their opinion the reduced capital cost per unit on a large plant is eliminated with higher transportation costs. This is a factor that will be reviewed in subsequent portions of this report.

End-Uses for this Product

Based on the advantages and disadvantages that we have previously outlined, the areas of opportunity for gypsum flakeboard at the present time appear to include thick panels for flooring, panels that provide a higher fire rating than regular plasterboard, panels that provide greater sound protection because of their density and panels with the above characteristics that can be modified by adding veneers and other coatings.

This product is being produced in order to compete with plywood, particleboard or regular gypsum wall board in the construction of houses and buildings. A limited amount of data on market trends and market penetration of this new product is provided further in the report. The concept proposed by the company suggests that because gypsum fiberboard (the basic gypsum board to which cellulose is added for increased strength) now accounts for nearly 15% of sales in Germany and is produced in a variety of other countries around the world, it follows that gypsum with wood flakes would even be better in terms of strength and would offer new opportunities in various fields of application. The characteristics that provide these panels with some competitive advantage in our opinion would include the fire resistance, the density, the relative strength and the potential for veneering and edge treatment.

It appears that this product could be situated in the marketplace between regular paper faced wallboard and regular particleboard. The biggest disadvantages to the product are likely to be its weight and its cost. The weight problem has manifested itself in the difficulty with which skilled labour has had in carrying the product and installing it. Recent information regarding gypsum particleboard application indicates some problems associated with skilled trade people requiring more adequate training to perfect the installation. Installation problems and the heavy weight of these panels has restricted the rapid acceptance of gypsum particleboard. However there is a feeling among some European producers that, with the lack of formaldehyde emissions and the absence of swelling characteristics plus the product's ability to meet the most stringent flame spread requirements, gypsum particleboard will compete strongly against conventional particleboard.

Initial Market Trends

Our research regarding the impact that gypsum bonded boards have made on the markets in Europe would suggest that in certain countries, a small portion of the particleboard market has been converted to this new product. The reason for this trend appears to be the significant concern in Europe regarding the formaldehyde content of the particleboard product and the general public feeling that a substitute product is required. More specific information and analysis on these trends is provided further in this report. More investigation is required regarding the use of gypsum bonded particleboard as a substitute for regular plaster board.

Cement Particleboard

The Product

This product is based on the use of Portland cement as a binder for wood chips. The furnish is mixed with cement and water, put into a forming station and formed onto cauls. Mats are clamped and stacked to harden in a heated chamber for a number of hours. Panels are then stacked for curing which can take up to 10 days.

A comparison of this product with regular particleboard and regular gypsum board is provided in Exhibit V.

This product dates back to the 1930's when light weight wood wool slabs were developed in Europe and in North America. In the early 50's American product was developed by Elmendorf using chips and shavings and this company subsequently filed a series of patents. More development was done in Switzerland in the late 60's and a pilot plant was set up near Zurich. More information on the technical assessment of this product is provided in a report produced by the Building Research Station in the United Kingdom (see Appendix III).

EXHIBIT V

COMPARISON OF GYPSUM BOARD TO CEMENT-BONDED PARTICLEBOARD AND REGULAR PARTICLEBOARD

Property	Units	Gypsum Board*			Cement-bonded P/board**	Regular P/board
Specific Weight	kg/m^3	1000	1100	1200	1250	700
Modulus of Rupture	N/mm^2	6	7.5	8.5	9	18
Modulus of Elasticity	$N/mm^2 x 10^3$	3	4	4.5	3.0	3.0
Linear Expansion	%	0.06	0.05	0.05	N/A	0.35
Surface Strength DIN 52 366	N/mm^2	0.25	0.28	0.35	N/A	0.8-1.0
Impact Strength BS 5669	mm	100	100	125	300	300
Internal Bond	N/mm^2	.25	0.3	0.4	0.8	0.4
Swelling-- 2 hrs. Soak DIN 52-364	%	2.6	2.5	2.5	1.0	8.0
Screw Withdrawal						
Edge	N/cm	250	300	300	N/A	3-400
Face	N/cm	650	700	700	N/A	6-900

---

* Data based on information supplied by Bison-Werk and refer to commercial product produced by the Finnish plant, Saastamoinen OY.

** Data based on information supplied by Duripanel and refer to commercial product produced by the West German plant Eternit AG.

The Plants and Machinery

Both Bison-Werke and Siempelkamp are very active in this market and have systems that produce not only panels but complete prefabricated structures of one form or another.

In recent years there appears to have been a general increase in the interest in cement-bonded particleboard and the World Wood Panel Review in August last year listed eleven of these plants in the following locations.

Soviet Union - 7
Hierges, France - 1
Thailand - 1
Wales - 1
Japan - 1

These plants have all been constructed in the past 24 months but in addition, there are a number of other plants in Europe as well as Mexico and Finland. To date Bison has constructed 25 cement-bonded particleboard mills throughout the world.

Some information on machinery that is necessary for this product is provided in Appendix IV.

The End-Uses

This product has established a fairly stable market in both exterior and interior applications, for example:

Exterior	Interior
prefabricated housing	partitions
cladding	non-flammable walls & ceilings
balcony parapets and floors	non-flammable furniture
industrial walls	shielding for steel supports
sound barriers	lining for high humidity rooms
garden walls	

Although this board has been produced in Europe for many years, the product is relatively new to countries like Finland, and non-existant here in Canada. The new plant in Wales is the first one in Britain, where the product has limited use at the present - mostly as a replacement for asbetos board and some application for raised flooring. Weight continues to be mentioned as one of the negatives to more wide spread use.

Market Trends

With limited information gathered on the market to this point in our study, it would appear that most of the production is being used to contruct housing in third world countries (that is to say, a large portion of cement board appears to be exported). In Europe, generally speaking, the efforts to increase the market penetration of formaldehyde free product into the traditional particleboard markets has had some success to the detriment of the conventional particleboard industry. At the present time we do not have the specific share of market that cement board commands in this area. One of the German plants produces a product called Duripanel which has been available for the past 7 years.

Generally speaking the product competes very well in areas where more sound proofing is required, fire retardency and resistance to moisture are needed.

PHASE II

In the second phase of this study we conducted interviews with market participants in the board industry in North America and in Europe - people including producers, distributors and contractors, to determine attitudes on and experience with to these types of products. The information received provided some insight into the "thinking" that relates to use of cement and gypsum bonded particleboards for construction purposes in Europe and here in North America.

THE EUROPEAN MARKETS

BACKGROUND

Wood based panels with organic binders have been in existence since the 1920's when cement bonded wood wool was regularly used as an insulation board for industry construction and for domestic housing.

The following exhibit demonstrates the chronological development of technology of structural boards commencing with the early 1900's and ending with the creation of the present day magnesium bonded particleboards and the gypsum bonded products.

EXHIBIT VI

CHRONOLOGICAL DEVELOPMENT OF TECHNOLOGY OF STRUCTURAL BOARDS

1900		tylolite boards	gypsum bonded wood wool building slabs	
10				
		magnesia bonded wood wool building slabs		gypsum plaster board
20				
30		cement bonded wood wool building slab		
40	moulded wood cement composites			
50			resin bonded wood particleboards	
60				
		cement bonded wood particleboards		
70				
1980	magnesia bonded wood particleboards			gypsum fibre boards
			gypsum bonded wood particleboards	

As the chart indicates, both cement and gypsum bonded product have been on the markets in various forms since the early 1900's. They were used as building slabs early on and later as flooring grade boards and wool tiles which were developed during the 1950's in the German Democratic Republic. The Soviets went on to make full sized wool boards during the 50's, but these boards were generally weak and it wasn't until the development of the higher density cement bonded product (1,100-1,300 kg. m3) that it became possible to use these boards in load bearing applications.

During the 70's and 80's a number of board alternatives have been developed in Europe using Portland Cement, Magnesium Cement (ground up slag) and gypsum cement (plaster of paris, either natural or synthetic) as the bonding agents. There appears to be two major reasons for the development of these products. The first one is that there has been a much slower acceptance in Europe generally speaking of gypsum wall board or dry wall as we know it than here in Canada. For example, although the United Kingdom's annual consumption of wall board both produced in that country and imported from the United States and Canada, is in the neighbourhood of 1 billion square feet, compared to Canadian and American usage, this is only 50% of what it could be based on population statistics. Although we have no figures for France, interviews with Lafarge representatives provided information to suggest that the market in that country was even less developed and that there was still some plaster and lathe usage.

However what has been used in many instances is "chip board" or particleboard as we know it. This product has enjoyed great success in the European common market, until recently when public concern over the potential harmful effects of the formaldehyde content of the product forced manufacturers to look for alternatives. Thus, in brochures promoting the various alternative cement and gypsum bonded products, we see references to the "lack of formaldehyde content".

Another reason for the development and improvement of various cement board products is that organizations are looking for a substitute for asbestos cement. While the fire rating on the asbestos boards was excellent, the health hazards, whether perceived or real, provided a serious negative marketing effect to the point where these products have been banned in numerous countries (the United States for example) and as a result, cement and gypsum board products are being offered as substitutes.

Prior to these public safety concerns over asbestos and formaldehyde, cement boards and gypsum boards had relatively little acceptance in Europe. Plants for these two basic types of product have been commissioned in various countries and in some cases closed down. For example, the Elmendorf company in California who originated the cement board technology finally sold this technology to Mitsui in Japan and exited the business. Mitsui has had success with this plant and has operated it since 1965. In fact there are three other plants producing this type in Japan, two with Nippon Hardboard and one with Sekisui Chemical. Thus, it appears that the product has had some market acceptance in Japan although total volume for these plants in that country is apparently extremely small (600 m^3 daily) which suggests a specialty market.

Duripanel, a product that was developed in Switzerland using a somewhat different technology as compared to the California Elmendorf product, is produced at least in one plant that we are aware of in Germany owned by Eternit-Werke. This plant was built in 1982 and operates currently to our knowledge on one shift with the capacity of roughly 125,000 square feet daily on three shifts. This is a relatively small quantity but the product has not gained great popularity in Germany. There were two of these plants in Germany. The first one produced by Fulgurit-Werke in the early 70's, was shut down in 1983 and we understand that it may be for sale.

Eternit also operates plants in Belgium and Denmark and a new plant opened in France in 1985 with a capacity of 100,000 square feet daily. There is also a new cement board operation in Southern Wales which should be operational within the next two months (Spring 1988).

Apart from these facilities most of the plants that produce this type of product are located in iron curtain countries or in the third world. In some situations the material is well suited for applications (mostly industrial and some housing) where extreme conditions prevail such as hot humid climates where a strong rot resistant product is necessary. Economically, these cement boards are generally more acceptable in countries where resin is not produced and therefore not generally available.

Turning to the gypsum bonded particleboard product, this item is so new that very few people are even aware of its existence. The volumes on the marketplace are extremely small because there is only one plant producing. This plant (located in Northern Finland) has a daily capacity of 100,000 square feet (three shifts), and ships most of the product into the USSR. Additionally, a small amount is being sold in Germany, the target market being as a substrate in the production of furniture. Promotional brochures in support of this product suggest that it can be used as an internal wall board - a replacement for regular gypsum drywall.

GYPSUM BONDED FIBREBOARD

The product in western Europe that has made some significant inroads into the marketplace is a combination of gypsum and cellulose. This mineral board, branded as "Fermacell" is produced by Fels-Werke and Peine-Salzgetter. The product went into commercial production in 1971 and there are now three factories in West Germany and eight others around the world.

The plant at Seesen, Germany, using technology developed by Fels-Werke and Siempelkamp has a production rate of 400,000 square feet daily on a three shift, 10 mm basis.

The two basic materials incorporated into the product are waste paper (newspapers and magazines) and stucco gypsum. Information on this process has been supplied in the appendix to this report.

Information provided by German contacts suggests that this product has gained between 10 and 15% of the wall board market in West Germany where it has found its greatest acceptance. The product derives strength, dimensional stability and fire retardant properties from the combination of the cellulose and gypsum and represents an improvement over conventional drywall gypsum board in strength and workability. In the following exhibit we have provided the location and types of plants that produce this type of product as well as the gypsum board products.

EXHIBIT VII

GYPSUM FIBREBOARD PLANTS IN 1987

Location	Company	Capacity
Israel	Tagiu Gypsum	560 m^2/hr.
Iran	Gatchsaan	560 m^2/hr.
*Germany (3)	Seesen	1800 m^2/hr.
Yugoslavia	Sipad	770 m^2/hr.
USSR (2)	Prommashimport	1500 m^2/hr.
Egypt (2)	Kuwaiti Egyptian Co.	750 m^2/hr.
India	Gypsum Fibre India Ltd.	750 m^2/hr.
Belgania	Stroyiimpex	750 m^2/hr.

* 2 parts of the 3 German plants are probably smaller than the 1800 m^2 capacity shown.

Source: World Wood

EXHIBIT VIII

GYPSUM BONDED PARTICLEBOARD PLANTS

Location	Company	Capacity
Kuopio, Finland	Saastimoinen	38,000 tonnes (33 million square feet 3/8" basis)
Mostjoen, Norway	Arbor A/S	60,000 tonnes (50 million square feet 3/8" basis)

SLAG BASED CEMENT BOARD

There are two essentially different cement based board products on the market - one using a Portland cement as a binder, the other using a special cement that is developed from waste slag produced as a by product from steel mills. This "slag based" cement board appears to be a slightly denser product than the Portland cement or the gypsum bonded products. However it is essentially an interior product at present, and it's primary advantage is that it has far greater fire resistance than any other form of regular particleboard. In the appendix of this study we provided some printed material on the "Ecocem" process that Raute offers. Another similar board is being produced in Finland by Metsa-Serla and a sample of the printed material on their product "Ilves" mineral has been included in the appendix of this report. Research did not indicate a particularly wide acceptance of this product and in fact, we were unable to determine specific prices for it in England because it wasn't being distributed. However they are similar to those being charged for regular cement board.

THE EUROPEAN MARKET SIZE ESTIMATES

One of the major conclusions that we have drawn from this study is that the market penetration of cement and gypsum bonded particleboards are small in the European countries where they are produced. Nevertheless, compared to North America where market penetration is extremely limited, there is a small percentage of market share as indicated in the following two exhibits (IX & X) for Germany and England.

EXHIBIT IX
ESTIMATED VOLUMES FOR SELECTED BOARD PRODUCTS
GERMANY - 1986

Cement Bonded Particleboard	10 million square feet
Gypsum Bonded Particleboard	1 million square feet
Gypsum Bonded Fibreboard	150-200 million square feet
Gypsum Board Drywall	15-20 billion square feet

EXHIBIT X

ESTIMATED VOLUMES FOR SELECTED BOARD PRODUCTS

ENGLAND - 1986

	Square Feet
Cement Bonded Particleboard	5,000,000
Gypsum Bonded Particleboard	NIL
Chipboard (Resin Bonded Particleboard)	23,680,000
Drywall	1,000,000
Plywood	500,000,000
OSB	20,000,000
MDF	SMALL

Source: D. G. Bell Estimates

Clearly the market penetration in both these countries is insignificant for cement bonded particleboard compared to other board products. In the case of the gypsum particleboard it is even less significant in Germany and non existent in England.

Application for the cement bonded product in both countries includes the following usage areas:

flat roof decking,
partitioning,
sheathing,
ceiling,
fire resistant doors,
general fire protection,
flooring,
external cladding,
tunnel lining,
fire resistance substrate for laminates

The list presents a versatile product that has the ability to penetrate markets of virtually all other sheet materials. Yet due to lack of sustained effort in part, the market is not developed as well as might have been expected. Perhaps the range of potential applications is in someway a drawback, as it has led to a failure to concentrate on the most suitable market segments.

By comparison, the gypsum bonded product while it is presented as a substitute for particleboard or drywall, is limited in its German use generally, to the furniture industry.

The reasons given in the first phase of this study regarding weight comparisons of cement and gypsum products versus regular particleboard or waferboard, were those used by the machinery manufacturers as a prime reason for low market acceptance of this product. Exhibit XI demonstrates an approximation of board weight comparisons for the various products showing particleboard as a base of "one" for equivalent ratios.

EXHIBIT XI

BOARD WEIGHT COMPARISONS

Board Product	lb/ft^3	Weight Ratio
MBPB	81.0	1.86
CBPB	74.5	1.70
GFB	71.8	1.64
GBPB	68.7	1.57
Drywall	53.1	1.21
Particleboard	43.7	1.00

Source: Abstract: Bison-Werke FRG - 1986

Clearly the cement and gypsum products do weight significantly greater amounts than the regular particleboard and drywall product. However, there is another more important reason for lack of acceptance of these boards and that is price.

In exhibit XII we provide a price comparison chart giving average distributor and end user pricing for a variety of board products. The pricing varies according to thickness and so for purposes of comparison, cubic meters were utilized as a standard measurement. These prices were then translated to a square foot basis using 3/8 as an average (but it must be recognized that all of the square foot pricing has been calculated based on the cubic metre pricing structure). Although, the figures may not be entirely accurate, they do give a relative pricing comparison for the various products. Pricing for gypsum fibreboard and gypsum particleboard have not been presented in this list because they were not found in the marketplace.

EXHIBIT XII

UK - BOARD PRICE COMPARISONS - 1987

Canadian $ (Exchange rate of $2.25 per pound)

	Distribution Price		End User Price	
	Cubic metre	Sq. ft. 3/8	Cubic metre	Sq. ft. 3/8
	$	$	$	$
Chipboard				
Regular	200-260	.20-.26	270-340	.27-.34
Flooring	260	.26	340	.34
Moisture Resistant	350	.35	460	.46
Flame Retardent	485	.48.5	640	.64
OSB	340	.34	420-530	.42-.57
Drywall	225	.22.5	260-280	.26-.28
CBPB	1070-1180	1.07-1.18	1800	1.80
Plywood				
Commercial Grade	900-1125	.90-1.12	1150-1380	1.15-1.38
Sheathing	340-415	.34-.41	415-560	.41-.56
Flame Retardent	900-1300	.90-1.30	1125-1630	1.12-1.67
MDF	440	.44	560-675	.56-.67

The pricing shows how much more the cost of the cement products are as compared to any of the other products in the marketplace. Thus, even though the specifications and product attributes of both gypsum and cement bonded particleboard may be superior in many respects to much of the competition, the pricing is such that these boards are only used in specialized situations. In most instances, the superior qualities in certain respects do not justify the increase in cost.

This conclusion has been borne out through our research and through interviews with many of the participants in the marketplace. For example, Lafarge representatives indicated to us that these board products are available in Europe, but because there is a gypsum wall board industry in almost every country, the market impact that they have made is neglectable because of the low cost of the drywall product. Should a superior more fire resistant more stable product be required, Lafarge and other board producers in Europe and in fact here in Canada, offer products that have the superior qualities and still cost less than these other products.

Although we were unable to obtain United Kingdom prices on gypsum bonded fibreboard and gypsum bonded particleboard we were given to understand through other sources that the price of the fibreboard was roughly 20% higher than standard drywall. The fact that this board has achieved market penetration of 10-15% in the Federal Republic of Germany suggests that there is a market niche for this type of product. But clearly, if the market increases in size for the fibreboard product in Germany and in other European countries, the large gypsum and cement based operations such as Lafarge will most certainly be offering this type of product.

The two main reasons for the significant price differential are firstly, the cost of the raw materials in some cases, and secondly the relatively slow production process that is used for cement and gypsum bonded particleboards. Gypsum fibreboard is somewhat of an exception in that the new high speed German plants can produce 1,800 square meters an hour which roughly equates to 110 million square feet annually but even this speed is one third the speed of a standard mill for regular drywall.

Turning to the gypsum bonded particleboard the only two plants in operation are producing with capacity of 43 and 55 million square feet on a 3/8" basis annually. Production figures for cement bonded particleboards indicate similar low annual productions of 100 cubic meters a day in France (which roughly equates to 25 million square feet) on a 3/8" basis and 14,000 cubic meters a year with a new plant in Wales which equates 14 million square feet on 3/8" basis.

Thus, the fixed costs in overhead for these operations cannot be spread out over a large quantity of sheets as they can for items such as OSB or particleboard.

It is difficult to see how these products could compete on a price basis with high volume less expensive building items such OSB or particleboard, unless the high production levels can be achieved.

What this conclusion infers is that these products, cement and gypsum bonded particleboards are going to be limited to specialized market niche opportunities where the higher prices can be justified by the need for a more durable product with particular qualities such as fire retardency, building strength and so on.

There are other reasons why these boards have not made more significant inroads into the marketplace. For example, with the cement products, one of the more opportune market niches is as a replacement for asbestos cement board which has been eliminated from many markets. However, the new cement bonded particleboard products have a greater propensity to break and chip, they cost generally more than the old asbestos cement items, and in some cases the tolerances have not been maintained as well.

Regarding the gypsum bonded particleboard products, the basic restriction that has been illustrated previously is the serious weight increase for this item versus drywall. But there are other reasons.

Glunz, the largest manufacturer of boards in Germany has been very interested in the gypsum particleboard product in Finland and has done a number of studies on the product. The company has also used its own existing production lines to produce some of the board products in Germany in order to test. Finally they conducted some feasibility studies and an external market study. Generally speaking the conclusions that the company arrived at were that the board had no major opportunities in Germany and that they (Glunz) would not be entering this marketplace. Press releases that the company prepared were biased (naturally) in favour of regular particleboard and drywall products. However they did make some points worth considering:

1. Any type of furniture made with this board as compared with particleboard, will weigh significantly more than furniture made with regular particleboard.

2. The gypsum bonded particleboards are more difficult to produce not only because of the time but also because of the quality of the plaster and the need for a consistent raw material supply.

3. Only round wood timber can be used in the construction of this product and therefore the cost is necessarily higher than some other alternative raw material possibilities.

The gypsum bonded particleboard product that is produced in Finland (soon to be produced in Norway) is too new to determine what market acceptance there may be but again, our conclusion is that this is a specialty product with limited volume potential as compared to the regular particleboard and drywall.

The cement board products are achieving some success in usage areas related to external areas where tougher demands are made on things such as fire resistance, sound proofing and in some cases strength. This is a low volume industrial product that will never compete directly with particleboard or OSB. Internally it is not really competitive with drywall because of its cost and although it has more resistance to moisture than some drywalls, this limitation can be overcome with specialty drywall products. In fact, many of the cement board products must be coated for external use.

Our overall conclusion regarding the progress that these cement and gypsum bonded particleboards have made in Europe is that they have attained some small success in specialty niche markets but that the overall long range opportunities are presently limited by virtue of the reasons previously given.

The gypsum fibreboard product that has gained some acceptance in Germany appears to have a longer term opportunity for market growth based on its ability to compete favourably with regular drywall.

THE MARKET OPPORTUNITY FOR MINERAL BONDED BOARD PRODUCTS IN NORTH AMERICA

THE CURRENT STATE OF THE MARKET FOR EXISTING PRODUCTS

Our original mandate in undertaking this market study was to assess the market demands for cement and gypsum bonded particleboards with emphasises on competitive products, volumes sold here in North America, attitudes of major users, and so forth. During the first phase of this study it became apparent that the market usage for these items was extremely limited, as was in fact, the knowledge of these products. The contractors, distributors, and end users of board products here in Canada and in the United States had little or no knowledge of these items. Thus, we determined the best approach would be to examine the relative success of these new board items in other parts of the world (such as Europe) and then to assess the potential for the original development of these products here in Canada and the United States.

The first question that needed analysis was, "how well are the board markets being serviced in North America" and secondly, "are there any market niches where new board products could be developed". The answer to the first question is that the board markets are extremely well serviced by existing products in the consumer and industrial segments of the board market with one or two small exceptions. For example, the furniture industry has accepted particleboard and new plants for this product are coming on stream regularly. Medium density fibreboard is gaining acceptance reasonably well and Canada now has two plants in operation. The wall board markets were relatively strong until the recent down turn in the United States housing starts market reduced the demand, but Canadian plants have been producing close to capacity.

Waferboard is slowly but surely taking over the construction grade plywood market and the product improvement (OSB) continues to enjoy an increased demand for this exterior use product.

Compared to Europe, there has not been a major public concern for formaldehyde content in particleboard here in Canada and the United States. The one health concern area that has forced a change in product uses has been in the asbestos cement board field. The concern over health has resulted in the banning of this product in the United States and although the product is still acceptable and legal here in Canada, usage is dropping significantly on a regular basis. Atlas Building Products in Montreal is producing less and less of their exterior sheathing for industry use and the new owners of this plant (a German and American consortium) have announced plans to launch a non-asbestos cement board by January of 1989. In fact one of the three board lines in the Hochelaga St. plant in Montreal has been closed down to allow for the major modifications necessary to produce the new board product.

Apart from concerns for asbestos, there have not been any health hazard issues of major proportions here, nor have there been comments regarding the inadequacy of present products. Thus, the conclusion is simply that the state of the market for existing products is strong and that present boards are meeting demands of the marketplace.

REASONS FOR LIMITED ACCEPTANCE OF THE NEW EUROPEAN BOARDS HERE IN NORTH AMERICA

One the major factors which is evident in our analysis of the market is that the interest and promotional support provided for most of these new board products emanates from the machinery manufacturers themselves. It is these companies who logically stand to gain significantly from the development of new board markets. This is easily demonstrated by looking at the number of new board plants in Europe that are partially owned by the machinery manufacturers themselves. Research into the interest levels developed here in North America causes us to conclude that the sources have generally come from companies or individuals interested in selling machinery. Interviews with representatives in the competitive board businesses such as drywall (Canadian Gypsum, Westroc, Domtar, Canada Cement, etc.) all demonstrated that their company laboratories had looked extensively at these products without giving serious consideration to their development here in North America, at least up to the present time. Common sense dictates that any considerable market opportunities would be followed by these companies whose best interests would be served by maintaining their own market shares.

The reasons for the non interest by the large manufacturers and in the limited market acceptability comes back to price, quality and product attributes. For example, the world price on average for gypsum drywall is approximately $110 US per thousand square feet on a 3/8" basis. To this base price one needs to add roughly 5% of the value each time an improvement is made for fire retardency, strength, sound proofing etc. so that the best panel is offered by these various companies somewhere in the region of three times a 5% increase over that base US price of $110. In fact this could be increased if there were some special demands made for an even better product. The point is that the price of this product is so inexpensive as compared to some of the other opportunities, that any market potential is going to be severely limited by virtue of the economics and the economics are about the same all over the world. The one significant difference that has been achieved with low cost wall board is where manufacturers have used recycled paper instead of virgin paper for the covering and this move has significantly reduced the production costs on this board. However it would appear from our interviews, that these savings have not to date been past on to the consumer.

Regarding cement board opportunities, the R & D labs at Canada Cement have produced half a dozen different board products which the company could manufacture if there was a market for the products. To date they have not determined any market opportunities, they felt to be significant.

THE LIKELY MARKET OPPORTUNITIES HERE IN CANADA

In our original submission we suggested following your terms of reference with respect to categories for product opportunities. The six categories included:

Cement Bonded Particleboard

1. Exterior cladding
2. Flooring and roofing
3. Interior wet applications
4. Treated wood foundation cladding

Gypsum Bonded Particleboard

1. Interior wall coverings
2. Furniture

At this point in our review we are able to make the following assessment regarding what possibilities there might be for development in any of these areas.

Cement Bonded Particleboard

Exterior Cladding

1. There is some opportunity to develop this market area for industrial building use. Limited use in apartment buildings or condominiums is possible, providing some type of finish is given the product (spray coated with some form of moisture resistant base).

2. There appears to be a fairly good opportunity for CBPB as a possible replacement for the present t-roof or cavity roof product that asbestos cement is presently used for here in Canada. Flooring is not a major possibility due to cost, except in specialized raised flooring applications.

3. For interior wet applications as a substrate for bathroom walls, this product is generally too costly. At the present time there are a number of companies in Canada producing a low cost cement base substrate that sells for roughly $1 per square foot and large companies who were offering a similar product have chosen to deemphasize these items because of the low volume and low value.

4. There is a small market for treat wood foundations particularly in western Canada. The cement bonded particleboard product may have to be treated for moisture proofing. Unless the cement board was less expensive, it does not appear to offer any significant product advantage over the treated wood product.

5. We also expressed an interest in the possibility of using the cement bonded product for sound barriers on highways. This market is extremely small. It has been variously estimated from 50 to 60 miles annually and a wide variety of products are being used depending upon the aesthetics and the availability of the particular products that may be required. The cement bonded particleboard product without any type of special coating to prevent moisture retention would not be acceptable. Further, present moulded cement board producers who provide some of the product advised us that competition from steel and composite board producers would soon force them out of much of this business.

Gypsum Bonded Particleboard

Interior Wall Coverings

There is no major market opportunity here in Canada where the product could compete directly with gypsum wall board. The specialty market for wall board is at best in our estimation 5% of the total wall market, and even at this point, the product would be competing directly with the "higher grade" wall board products.

Furniture

A small opportunity to offer a fire resistant furniture product but no advantage perceived over fire resistant particleboard or plywood. The product does not have machinability qualities or the strength the particleboard and MDF have to offer.

Fire doors was another area that we felt should be considered for this product. However, upon analysis of this market area we determined that a 45 minute fire rating core for a manufacturer presently costs roughly $35.00. Although a gypsum or cement based particleboard could be produced to qualify at this rating level, the price of the cement board would be at least 20% (minimum) higher than what is presently being used. Thus, here again, pricing of the product restricts the market opportunity.

In summary, the market potential for any reasonable volume appears to be directed to external wall cladding or a roofing deck product that is fire proof and that can compete physically and (to a lesser extent) from a price point of view with the present asbestos cement product that is being sold here in Canada (but not in the United States).

THE MARKET SIZES

The two market areas that provide some opportunity are the roofing market for industrial use and the exterior wall cladding industrial marketplace.

Exhibit XIII provides a rough estimate of the volumes of product that are consumed in these markets in North America. Although large, there are many competitors including the metal decks, plywood and waferboard, precast, concrete, fibreglass, etc.

Samples of some of the competing product printed material in roofing, sheathing and exterior cladding have been provided in the appendix. The main opportunity appears to be the replacement market for asbestos cement and as previously indicated, Atlas Building Products here in Canada (a major competitor) is moving to produce a non-asbestos cement board item to meet the market demand.

At the same time, the Eternit Corporation with plants in Belgium and Denmark among other areas, have made a serious effort to enter the North American marketplace with a variety of cement board products. A major distribution centre has been established in Reading Pennsylvania and "street talk" is that they are evaluating the potential for the establishment of a production facility in North America. The fact that they own Turners in England which is also part of Atlas in Montreal, might cause one to speculate if they are perhaps involved in the present plant modifications. However at this point in time, they have elected to import the board products from their Belgium operations, presumably because the volume here in North America does not justify production, and excess capacity in Belgium offers an export opportunity.

EXHIBIT XIII
INDUSTRIAL ROOFS & WALL SHEATHING
ESTIMATED MARKET* FOR 1988
U.S. & CANADA
(Sq. ft.)

	Walls & Other Applications	Roofing
CANADA	200 million	141 million
USA	2 billion	1.5 billion

* Does not include any repairs
Source: Canadata & D. G. Bell Estimates

Exhibit XIV provides a price comparison for some of the board products versus comparable asbestos product that are being offered in the marketplace.

EXHIBIT XIV

CANADIAN DISTRIBUTION PRICING FOR

CEMENT BOARD

Product	Size	List Prices
Flexboard N. (ex Johns Manville Non asbestos Sheeting	4x8x1/4"	$2.03 p.s.f.
Sterlingboard (glass reinforced mineral board)	4x8x1/4"	1.72 p.s.f.
Ultraboard (cellulose reinforced mineral board)	4x8x1/4"	2.13 p.s.f
Eterboard Eternit (cement board)	1/4"	2.69 p.s.f.
Asbestos Cement Board	1/4"	2.00 p.s.f.
Cement Substrate Board for Bathrooms	1/2"	1.00 p.s.f.
Utility Grade Asbestos Board	3/8"	2.76 p.s.f.
Eterspan (Eternit) Cement Board	3/8"	2.69 p.s.f.

Source: D. G. Bell Interviews

Comments made be distributors indicated that while the decrease in volume (or disappearance from the marketplace in the case of the United States) of asbestos fibreboard left a void to be filled, the cement board products have not taken off in major volume increases. The reasons for this are apparently the prices which have been higher than asbestos and secondly the boards are more difficult to work and more prone to chipping and breakage than what contractors have been used to.

As a result, for example, the Canadian distributor for Eternit products indicated that he had only sold two jobs using the Eterspan product (both of these in the Edmonton area). However he was confident that because of the present competitive pricing policy that the American company has, he will see an increase in this product category. Products such as Eterboard are still presently significantly higher priced than asbestos cement board but with the decrease in the latter's volume and Eternit's apparent determination to increase its market share, one might expect the volume for the new cement board to increase.

Information secured on the American market indicates that this type of board has enjoyed some significant acceptance south of the border as a replacement for asbestos, (thus, the company's plans to consider a North American production facility).

SOURCES OF RAW MATERIAL

Consideration to enter this marketplace must be tempered by the location of the raw material sources as well as the end user markets. The raw material sources are listed in the following exhibit. The four basic products are Portland Cement, Magnesium Cement (ground up slab from steel mills), Synthetic or Natural Gypsum, Round Wood Chips, and Waste Paper. Some of the specifications for these raw materials have been provided in the appendix of this report.

EXHIBIT XV

RAW MATERIAL SOURCES

Edmonton & Fort Macleod	Portland Cement	Inland
	Magnesium Cement	N/A
	Waste Paper	Allied
	National Gypsum	Westroc
	Synthetic Gypsum	Esso Chemical
Picton/Belleville	Portland Cement	Canada Cement, St. Mary's Cement
	Magnesium Cement	Stelco, Dofasco
	Waste Paper	Consolidated Fibre
	Natural Gypsum	Westrod, Canadian Gypsum

Price estimates based on the present market situation have been provided in exhibit XVI. Locations in southern Alberta, northern Alberta and south central Ontario were used as comparison points for two reasons: a) because of the sources of raw materials, and b) because of the relationship to the end user markets.

EXHIBIT XVI

RAW MATERIAL PRICE ESTIMATES

$

Products	Edmonton	Fort Macleod	Belleville
Portland Cement/tonne	128.50	118	$117
National Gypsum/ton	27-29	19-20	23-25
Synthetic Gypsum/ton	5-10	—	
Waste Paper/ton	75-100	75-100	75-100
Round Wood Chips/ton	55	55	45-55

Exhibit XVII provides an estimate of the quantities of material that would be required for an output of 10,000 cubic meters product annually (although presumably the plant would be much larger than this).

EXHIBIT XVII

RAW MATERIAL ANNUAL REQUIREMENTS ESTIMATE

(Based on a output of 10,000 cubic meters)

Product	Raw Material	Quantity Required
GBPB 1200 kg/m^3	Gypsum - 81%	9720 tonnes
	Wood Chips - 19%	1181 tonnes
CBPB 1300 kg/m^3	Portland Chips - 60%	7800 tonnes
	Wood Chips - 20%	2600 tonnes
GBFB 1200 kg/m^3	Gypsum - 82%	9840 tonnes
	Paper - 18%	2160 tonnes
MBPB 1300 kg/m^3	Slag - 70%	9100 tonnes
	Wood Chips - 30%	3900 tonnes

A production facility in the Edmonton vicinity will have no trouble in securing any of the raw materials. The one restrictive concern that would need to be reviewed thoroughly is that the synthetic gypsum available in large quantities from Esso Chemical is radioactive and this would have to be corrected before usage or production took place. Although the amount of radioactivity is extremely small, it is highly unlikely that public acceptance could be secured for a new board product even though the levels of radiation were insignificant.

Western supply of natural gypsum is actually less expensive at the source than what is available in southern Ontario (most of which is accounted for by wall board production at the present time). The Windermere mining facility in British Columbia, roughly 170 million west of Calgary, could supply a new Alberta plant. The price of this raw material is relatively inexpensive as compared to what could be expected in eastern Canada. However the cost of transportation from the mine to Fort Macleod or Edmonton brings it into a price range that is roughly the same or in some cases a little higher than in Ontario.

Pricing for both the chip raw material and the cement raw material is competitive in each of the two areas of consideration.

THE TRANSPORTATION FACTOR

The relative weight of both cement and gypsum boards suggests that transportation is a major cost factor that needs analysis. General comments from European machinery manufacturers as well as UK consultants and gypsum board manufacturers here in Canada all suggested that with the significant transportation cost, locating the plant close to the end use market was valuable. One machinery manufacturer was recommending that potential buyers consider smaller production facilities in order to reduce the capital cost investment on the theory that the reduction in cost efficiencies of the plant would be offset by the lower continuing transportation costs to the market.

In theory this may sound reasonable, but when one considers that any of these small plants produce board of significant cost, the transportation factor, while being of some significance, is much less significant on a percentage basis.

Thus, for example, while the gypsum board manufacturers here in Canada rarely ship product across the country because of the cost factor, it must be remembered that these companies are dealing with a very low cost board. By comparison, a cement bonded particleboard which is being offered at 10 times the price of a drywall product will be far more capable of absorbing the transportation costs.

An assessment of transportation costs for board products based on an Edmonton to Toronto charge is $5.65/100 lb. weight. Since a cement board weighs 60-70% more than a particleboard product, it follows that the cost of moving the heavier board product into the eastern Canadian marketplace is going to increase by roughly the same percentage.

However, on a per sheet basis the actual cost increase is probably going to be in the neighbourhood of a $1.75. Given that the cost of a 4x8 quarter inch sheet of cement board is likely to cost roughly $65 at the distributor, the total transportation cost is only 5% of the total price of the board item and this is certainly within the range of the relative costs of shipping other board products in this country.

Thus, our opinion based on these preliminary calculations would be that a cement type board plant located in the province of Alberta could compete in eastern Canada or the western portion of the United States without concern for transportation.

The one concern is that if there should be more than one board plant of this type in existence, then the western Canadian company would be faced with marginally higher production costs for transportation, in the order of 2-3%. In the construction market 2-3% can be extremely important so that under heavy competitive conditions, the western Canadian company would be faced with the need to operate on more efficient margins or "absorb the cost of the transportation".

CONCLUSIONS & RECOMMENDATIONS

Based on our assessment of market development for these products in Europe and the degree of acceptance that they have received thus far, in other parts of the world and here in North America, our conclusion is that the opportunity for development of a cement or a gypsum based particleboard does exist in specialty markets. This does not mean to indicate that the market is not sufficiently large to encourage one or more companies from seriously considering an investment into this new board segment. On the contrary, we project that a company such as Atlas or Eternit will eventually produce here in North America. However, neither of these products offer significant substitute opportunities for volume items such as plywood, waferboard, oriented strand board, or particleboard. As a substitute for particleboard it is too heavy, too expensive and only has possible use (whether it be cement board or gypsum board) in situations where perhaps fire resistance is an absolute necessity. Having said that, there are other products that compete just as well.

As a substitute for drywall the product is more costly and thus again would only be used in specialty situations.

The main short term opportunity for cement board appears to be as a replacement for the asbestos cement products.

The main opportunity for the gypsum bonded particleboard appears to be as a specialty drywall product with some possible usage as an alternative for particleboard in the furniture industry (however this is very limited). During the first phase of this study we suggested that there was an advantage to using this product without taping. Although we have research to indicate that this is so, it is biased, and we have no particular examples of the product competing favourably because of a reduction in the labour costs. Since there is only one manufacturer of the product in the whole world, with a second one about to come on stream, it is somewhat difficult to establish what the market potential might be, except that the product advantages do not out weigh the cost factors at this point in time.

In our view, few companies are going to be interested in risking a major investment such as what is proposed, for any of these plants for a questionable return where the market is unknown. What is more likely, is that "lead markets" could be established to test North American waters using imported board, such as what Eternit has created with their American distribution exercise. This is a reasonable option and may in fact result in the establishment of a plant.

The potential for the development of the Ilves mineral board with new more efficient production methodologies offers some potential hope in the future. Representatives of the machinery companies involved in this product claimed that all R & D efforts were being directed towards the ability to produce this product at high continuous speed. This board should be produced close to the raw material source which means a location in Ontario or Nova Scotia as far as Canada is concerned.

In summary, we are of the opinion that future development of both the cement and gypsum product areas will be directed at specialty market sectors, likely spearheaded by those cement and gypsum based companies who are already abrest of the R & D in the "heavy board" categories and who have a vested interested in these areas.

Our recommendation would be twofold:

1. As a policy, the Corporation should continue to monitor the activities in the board business, simply to be aware of how competitive products such as what we have described here, are developing in the North American sector. Changes in the marketplace and improvements in manufacturing abilities can alter statistics significantly and offer market potential for new product.

2. The second recommendation is that there is a relatively easy and low cost way of assessing a North American market for these products and that is to consider a test market utilizing imported product from manufacturing facilities in Europe. There is no reason to think that a Canadian company could not conduct a projectable test market utilizing Belgian cement board or Finnish gypsum bonded particleboard, just as in some ways, the Eternit Corporation is conducting a similar experiment in the United States, although on a larger scale.

   We would propose that if corporate management determines that further action is warranted, a test market be considered in one segment of the country with a plan developed so that it can be projected on an international scale based on the results of the test. The purpose of the test would be to determine the market feasibility for sales and potential production of these products here in Canada for national and international distribution. If the test market were properly developed, it is likely that most or all of the costs could be recouped. A positive result in the market would indicate that a financial analysis be undertaken on the potential for production here in Canada. A market test failure would confirm the lack of opportunity and save any further expenses or investment, whether they be in capital equipment or employee and management time considerations.

   Careful measurement of the test market results in terms of sales, product problems, margin potential, dealer attitudes and end user attitudes would all be of course extremely important. Key questions that would need to be resolved initially would include the products that need to be tested, the market segments that should be targeted and the test area to be considered.

APPENDIX I

Technological Steps

The basic raw materials used in gypsum flakeboard production are: gypsum, wood and water with some chemicals influencing the chemical reaction/hydration to become dihydrate. The various technological steps involved in the production of gypsum flakeboard are:

1. Calcination of gypsum. A pneumatic conveying system takes the stucco to the board plant.

2. Flaking of wood with further disintegration. Coarse flakes are screened off and refined. Flakes will be stored intermediately.

3. Automatic control of moisture content and computerized determination of the required quantity of water to be added.

4. Metering of flakes and hemihydrate.

5. Mixing.

6. Forming of board-type material mats, continuously spread.

7. Pressing of panels in long-term pressing at approximately 280-370 psi (20 - 25 kp/cm2), designed for the specific hydration characteristics of stucco.

8. Drying of boards to eliminate about 15% excess moisture at low temperature to avoid re-hydration.

9. Trimming and/or cutting to size of panel by conventional saws, stacking afterwards.

Sources of Gypsum

The sources of gypsum can be either natural, crude gypsum or artificial gypsum from phosphoric acid factories or from flue gas desulphurization. The gypsum from either source has to be calcined in a conventional calciner. Special treatment of phospho-gypsum makes this cheap, raw material suitable for use.

Preparation of Chips

Logs are debarked and flaked. Peeler cores or planer shavings from plywood plants can be used also.

Flakes are handled the same as in the particleboard industry. This means that after intermediate storage, the flakes have been hammermilled and/or refined. The equipment to be used is standard. The goals is to get a flake which is thin, but which has sufficient tensile strength to reinforce the gypsum matrix.

It is important that the flakes are not dried. Exactly the opposite is desired because the natural moisture content of the wood will be used because of the wet surface of the flakes.

Mixing, Forming and Pressing

Stucco and flakes are brought together after adding a certain quantity of water. This quantity is based on the natural moisture content of the flakes which has been measured automatically. A computerized system calculates the water proportion to be added. Chemicals for influencing the beginning and the end of hydration will be added to this water.

These components are mixed intensively by a specially designed mixer, so that all the gypsum obtains that quantity of water which is slightly higher than the portion which is need stoichiometrically. Despite the intensity of the mixing, the flakes are not harmed as far as length is concerned. The mixture of the components is semi-dry and can be transported afterwards by conventional conveyors to the special forming station.

This forming machine is based on equipment from particleboard plants. A special air-classifying system insures a smooth surface on both sides of the panel. The center of the panel is spread without classifying. A profile of the panel would show higher densities at the two surfaces which increases the bending strength. Forming is of high accuracy as a precondition for constant quality of the panel, i.e. density, thickness tolerance, and strength. All of these properties are equal in both directions lengthwise and across the direction of production.

After forming, the weight of the panel can be measured. If necessary, misspread mats can be taken out automatically. Such material will be recycled. Mats are conveyed to the press system; the design of which depends on the characteristics of the stucco, i.e., the hydration periods.

If timber contains ingredients which retard cure and influences the setting time of stucco, or if the stucco itself has an extremely long hydration time, then a retarding system can be applied. In such a case, a pressing system for long-term hydration will be used. The panels will leave the pressing system after hydration has been terminated. This is one of the keys for high-strength properties and very good screw and nail-holding abilities.

If it is found that the wood is not influencing the setting time of stucco and, also, if the stucco can be accelerated, then other pressing systems can be used (for instance, continuous presses). For small or medium plant capacities, an investment for a continuous press might be too high and will influence the production cost per unit in a negative way. Further developments should find a way to chemically retard the reaction after adding water, i.e., to prolong this time. On the other hand, the setting time after the beginning of hydration should be accelerated.

Drying

After the end of hydration, which means immediately after pressing, the panels are conveyed to a conventional panel dryer. Due to the low moisture content of these green panels, the dryers can be much smaller than those used for conventional plasterboard or gypsum fiberboard. The energy consumption is up to 70% lower. The final moisture content within the flaker is about 2.5%.

Drying temperatures are low due to the low moisture content and corresponding evaporation of water. Drying time depends on the thickness of the mat. When leaving the dryer, the temperature will be less than 40 C. Immediately after this step, the panels are conveyed to a standard saw for edge trimming and/or cutting to size. After sawing, the panels can be stacked and conveyed for foil packing.

Not only the trimmings or cuttings can be recycled, but rejected materials can be milled and used again. A mixture of dihydrate and dry flakes can be put into calcination again. Flakes do not influence the calcination process of dihydrate.

Final Treatment of Boards

There are several possibilities available for the final treatment of the gypsum flakeboard panel. These include:

1. Sanding of one or two sides if thickness tolerances have to be exact, depending upon special requirements (as for flooring).

2. Edge treatment (for instance, for ceiling purposes or flooring extra thick partioning may require tongue-and-groove systems.

3. Surface impregnation, if water or moisture absorption has to be reduced.

4. Surface treatment with paints, foils, or papers with conventional equipment.

5. Surface lamination with wood veneers for wall cladding with an excellent fire rating.

All the various steps should be separate procedures independent from the board plant because only certain parts of the output will be treated in one or the other way.

Summary/Outlook

As mentioned above, the availability of any kind of gypsum (artificial or natural) as well as timber allows the installation of gypsum flakeboard plants in many areas. Even if the quality of stucco were not sufficient, the reinforcing flakes and the special pressing technique would give a panel with good quality and strength. Also, other fibrous materials from annual plants like straw, cotton stalks, or rice straw have been tested with positive results, but sometimes lower MOR. There is no need for special papers or collection of waste paper for the production of fibers.

The machinery is already of proven standard due to the utilization of equipment from other technologies. The plant design allows for small and medium-sized capacities. The installation of a plant designed for large production capacity, as is known in the plasterboard industry, is not recommended any more. This is because the positive aspect of reduced capital cost per unit would be eliminated by the addition of high transport costs to bigger market areas (if a cheap product has to be transported over long distances). The corresponding costs have been increased drastically during the past years, so that today they are often higher than the fixed cost of any building panel. Therefore, a plant design with up to 60 million feet per year seems to be at an economical optimum to serve a limited area of the market at lower transport cost.

In some countries, it might be interesting in the future to locate such board plants near to disposal of FDG gypsum, that means next to power plants. This raw material will be offered at low cost or even with a premium. Because power plants are normally near areas of high population, the above mentioned recommendation for such location does reduce transport of panels. Whether this idea is also right for phospho-gypsum (as a by-product from fertilizer or phospho-acid plants) has to be analyzed in detail.

The first plant in operation

On October 11, 1985, the first plant to produce the new type of panel was officially inaugerated. The plant is located in Kuopio, about 450 kms north of Helsinki, Finland. Basic decisions were made in 1984, civil works started in October 1984, assembly took place from April until September 1985 with the first load test. Capacity will reach more than 45,000 tons per year. Raw materials are local timber species and waste gypsum from a phosphoric acid plant near Kuopio.

The range of products will be stucco for general purposes (cement retarder, joint filler, bonding plaster); gypsum boards (standard) having the following characteristics; density: adjustable between 60-75 lb/ft2 (1.0-1.2 t/m3), thickness: 3/8 - 1 inc. (8 - 22 mm, even 28 mm), panel width: 4 ft. (1.2 - 1.25 m), panel length: 10 ft. (2.44 - 3.05 m); and gypsum boards (special) which can be edge treated by, for instance, tongue-and-groove, sanded on one or two sides, or handy-sized for one-man handling. The next plant will be installed during 1987 in Norway about 600 kms north of Trondheim. The materials which follow show the cost data for this board plant.

APPENDIX II

Data for a Board Plant

(calcination not included)

Capacity	
Per year (300 working days):	up to 1,700,000 sheets 4 by 8 ft. up to 65 million ft^2 5/16 in. up to 55 million ft^2 3/8 in. up to 44 million ft^2 1/2 in.
Volume:	up to 300 ft^3/hour or 20 million ft^2 yr.
Panel Size	
Width:	4 ft
Length:	8- 10 ft. adjustable
Thickness:	(1/4 in.) .. 5/16 in. (1-1/4 in.)
Density of panel:	60-75 lb/ft^3 adjustable
Raw Material Input (per ft^3 of finished product)	
Hemihydrate:	40 - 55 lb.
Flakes (oven dried):	20 - 30% (about 10 lb/ft^3)
Water:	about 10 lb (depending on moisture content of flakes)
Factory Buildings	
Under roof:	about 40,000 ft^2, i.e. about 1 mill. ft^3
Storage:	upon request
Total space:	60 - 80,000 ft^2
Operators	- wood yard including flaking/refining (2 shifts) - mixing, forming and pressing - drying, trimming - packing, storage (2 shifts) - shift leader - 4 to 5 per shift

Investment

Special equipment (to be imported) Includes engineering and know-how: (depending on splitting of the total volume)	\$3 - 4 million (U.S. funds)

General Equipment

Local Supply	\$3 - 4 million (U.S. funds)
Shipment of equipment, assembly, commissioning:	up to \$1 million (U.S. funds)

Plus: contingencies, duties, local fees, local management, civil works, and working capital.

Time Schedule

Shipment of equipment	12 months
Assembly	3 - 4 months
Commissioning:	1 - 2 months

Energy Requirement

Heat for drying	about 18,000 kJ/ft^3
Electrical power:	about 3.5 kWh/ft^3

Estimation for Calcination

Capacity	8 standard hr/min
Building:	6,000 ft^2, i.e., 200,000 ft^3
Investment:	\$2 - 2.5 million (U.S. funds)

APPENDIX III

CEMENT-BONDED PARTICLEBOARD

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Wood cement particleboard — a technical assessment

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Wood cement particleboard which is available under a range of brand names has evolved as a high density smooth-surfaced board with promising characteristics for exterior use or where high fire resistance is needed. This paper assesses the physical and mechanical properties of a representative selection of boards in three different thickness classes. Present and future uses for the product are discussed.

INTRODUCTION

The commercially successful combination of wood and cement to produce a board dates from the early nineteen thirties with the development of light-weight wood wool slabs using initially magnesite as a binder, but later adopting Portland cement. These early light-weight boards were known in Europe under the name of 'Heraklith', and in North America as 'Excelsior' boards.

The addition of planer shavings and thin chips to the American product led to the development by Elmendorf Inc of a high-density wood cement board for the building industry and the filing of a series of patents from 1954 to 1965. The concept of a high-density board using chips was taken up and developed in Switzerland with slight modifications to the Elmendorf patents, and in 1968/69 a pilot plant was set up at Dietikon, near Zurich, by Durisol Villmergen AG. This plant, with a daily production of 20 m³, produced a three layer board that became known as a C-B board: while the centre layer had small chips and flakes, the surface layers comprised wood strands some 30 mm in length, usually randomly arranged, but sometimes oriented.

Further development work by Durisol AG followed which led to the production of a smooth, fine-grained, cement enriched surface, characteristic of the present day boards. In 1974 a new plant incorporating air grading of the wood chips in the forming station was set up at Dietikon to produce about 30 m³/day of the first smooth surfaced cement board and sold under the name of 'Duripanel'.

While the original pilot plant was sold to Vietnam in 1976 to produce cement boards using hardwood timbers, plans were set in motion to erect plants in both Germany (Wunstorf) and Hungary (Szombathely) under licence from Duripanel. Both plants came on stream 1977/78, the German plant producing about 50 m³/day and the Hungarian 100 m³/day, later increasing to 160 m³/day. The products were first imported into the UK in mid-1978 under the names 'Fulgurit' and 'Granyp' respectively. More recently 'Fulgurit' has also been available under the name 'Cemchip'.

In 1978 Durisol AG was taken over by Eternit but in 1980 fire completely destroyed the plant at Dietikon. A new plant was started and commissioned late in 1981 at Neubeckum in Germany, 'Duripanel' boards from this plant coming into the UK early in 1982.

1982 also saw the commissioning of a further two plants, one on the outskirts of Kuala Lumpur, Malaysia, designed to produce some 120 m³/day of cement board from rubber tree wood, and the second in Japan with a similar capacity; the Malaysian board is imported into the UK where it is sold under the name 'Tacpanel' though it is known as 'Cemboard' in the rest of the world.

A further two plants are known to be under construction — one in Mexico, the other in Russia, where a further six plants are reported to have been ordered. It has recently been announced that work will commence in early 1983 on the construction of a 100 m³/day plant in the UK for Duripanel (UK) Ltd.

All the above products are based on Portland cement as a binder for the wood chips. However in 1981 there appeared on the UK market a wood cement particleboard using magnesite as a binder: bond strength is much higher with magnesite than with Portland cement, but unfortunately this is attained at the expense of much lower water resistance. Produced by Metsaliiton Teollisuus Oy of Finland, this magnesite board is sold in the UK under the name 'Ilves Mineral' (Table 1).

PROCESSING

Following storage for at least three months the debarked softwood logs of selected species are reduced to flakes some 10-30 mm in length and 0.2-0.3 mm in thickness using drum knife flaking machines. After passing through a hammermill the flakes are separated into surface and core material by screening, and are then mixed with Portland cement (excepting the Ilves Mineral board) and water in the ratio by weight of: cement 60 per cent, wood 20 per cent, water 20 per cent. The moisture content of the chips is monitored continuously and the volume of water added to the mix is adjusted accordingly. Small quantities of chemicals are added to the wet mix, one of the purposes of which is to accelerate cement setting.

The mixed furnish is fed to the forming station which spreads, under automatic control, a continuous mat of uniform thickness on to an endless series of caul plates running on a conveyor. The mat is cut into lengths corresponding

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Table 1 Wood cement particleboards produced up to early 1983

UK trade name	Manufacturer	Location	Design capacity of plant (m^3/day)	Comments
Duripanel	Durisol AG	Dietikon (Switzerland)	30	up to 1979
Duripanel	Eternit	Neubeckum (Germany)	150	from 1981
Fulgurit/Cemchip	Fulgurit V mbH	Wunstorf (Germany)	50 + 30	a BISON-WERKE plant, extended 1979
Granyp	West Hungarian Timber Combine	Szombathely (Hungary)	160	on 3 shifts:a BISON-WERKE plant
Ilves Mineral	Metsaliiton Teollisuus Oy	Hameelinna (Finland)	?	magnesite bonded
Tacpanel	Cemboard (Malaysia) Sdn Bhd	Kuala Lumpur (Malaysia)	120	a BISON-WERKE plant
—*	—	Vietnam	20	original pilot plant
—*	—	Japan	120	a BISON-WERKE plant
Fama panel*	Fama	Milan (Italy)	40	—
—*	—	Mexico	120	a BISON-WERKE plant

* Not imported

to the size of the caul plate and a stack of these is compressed together at a pressure of about 2.4 N/mm^2 to about a third of its original height over a period of 2-3 minutes. While still in the press, clamping arms are attached to the stack of cauls so that, on release from the press, the batch of cauls is still held in a compressed state. These are transferred to a heated chamber at 70-80°C for 6 to 8 hours to allow the cement to harden. At the end of this period the clamps are released, the cauls are removed and the boards dried, trimmed and then stacked for 12 to 18 days to allow the cement to cure; the boards are further dried and conditioned prior to shipment and can be sanded on one or both sides. Common board thicknesses are 12 mm and 18 mm but boards down to 8 mm and up to 40 mm are also produced.

Plant capacities at present are low, with production values of 50, 100 and 200 m^3/day, well below that of new chipboard plants, which usually produce in excess of 600 m^3/day.

PRL STUDIES

Wood cement particleboard established itself in Switzerland and Central Europe in the mid-nineteen seventies as an exterior board of considerable merit, especially in terms of durability, stability and incombustibility. PRL has maintained an active interest in developments in Europe, obtaining early samples of 'Duripanel' in 1973 and 'Fulgurit' in 1977, some time prior to their introduction to the UK. A preliminary evaluation of wood cement particleboard and an assessment of its potential was carried out by PRL and published as BRE Information Sheet 2/78 early in 1978.

The importation of wood cement particleboard from Hungary as well as from Switzerland and Germany, the availability of these products in an ever widening range of thicknesses, and the general interest shown in the material resulted in the initiation at PRL in 1980 of a more comprehensive evaluation of the product. Three sheets each of 8/9 mm (2 of 8, 1 of 9) and 18 mm board, and six sheets of 12 mm board of 'Duripanel', 'Fulgurit' and 'Granyp' were purchased on the open market and an assessment made of a very wide range of physical and mechanical properties. A limited assessment of boards thicker than 18 mm was also undertaken.

Over the last two years wood cement particleboard began to appear on the UK market from Neubeckum ('Duripanel'), from Finland ('Ilves Mineral') and from Malaysia ('Tacpanel'). The investigation was extended to cover these new boards but in order to cause the minimum delay to the publication of the original data, evaluation of the new boards was generally limited to those of 12 mm in thickness.

PROPERTIES

The physical and mechanical properties of the boards were evaluated using test methods described in BS 5669:1979 'Specification for wood chipboard and methods of test for particleboard'. Test data for a number of thickness classes are presented in Table 2 in the form of a mean value and range of values taken over all the brands examined. Because of the very different performance of the magnesite bonded product, test data for this board have been presented separately from those of the Portland cement bonded products. For comparative purposes the corresponding requirements in BS 5669 for general purpose chipboard (Type I), flooring grade (Type II) and moisture resistant chipboard (Type III) are also included in Table 2.

The test results obtained are generally higher than those given in the manufacturers' literature; when comparing the test data with the BS 5669 values for chipboard it should be appreciated that the latter values represent minimum levels for compliance and many chipboards have property levels considerably in excess of these minimum values.

Considering first the Portland cement bonded products it will be noted from Table 2 that the bending strength (modulus of rupture) is lower than the BS Type I values and appreciably lower than Types II and III; impact resistance is also much lower than that of Type II chipboard. On the other hand the modulus of elasticity (stiffness), and tensile strength perpendicular to the plane of the board (internal bond strength) are higher than those for chipboard while the thickness and length swelling after either water soaking or humidity change are markedly lower.

All the Portland cement boards (with the exception of boards in two thicknesses of one brand which failed the tensile perpendicular retention requirements) comfortably passed the rather arduous V313 test, an accelerated ageing technique embracing 3 cycles each of 72 hours water soak at 20°C, 24 hours freezing at − 12°C, and 72 hours drying at 70°C. Data on natural weathering of these boards are scarce and are restricted to early production samples placed on the weathering site at PRL in 1977. (The mechanical properties of this board when new were described in Information Sheet 2/78.) All the strength and stiffness properties show the same trend as illustrated in Figure 1 for tensile perpendicular strength: values show a progressive increase up to three years exposure, with a subsequent possible decrease towards the five year mark. The corresponding loss in strength of a very good quality moisture resistant chipboard is included for comparison.

Long term performance of these boards under external conditions appears to be distinctly promising, not only in terms of the good performance of the cement bond in the presence of moisture, as discussed above, but also in relation to the induced high resistance of the wood chips to insect and fungal attack as a result of the high alkalinity of the pro-

Table 2 Comparison of the mean value and range of test results of wood cement particleboard (excluding pre-production boards) with minimum values given in BS 5669 for wood chipboard

	Portland cement bonded boards					Magnesite	Chipboard in BS 5669 (6 – 19 mm)		
	8/9 mm	12 mm	18 mm	24 mm	28 mm	12 mm	Type I	Type II	Type III
Consignments tested (of different brands or different purchases of the same brand)	3	4	6	1	1	1	–	–	–
Thickness (mm)	7.86, 7.91, 9.00	12.11(*11.97 – 12.34*)	17.89(*17.76 – 18.17*)	23.69	27.75	12.40	–	–	–
Density (kg/m³)	1330(*1290 – 1380*)	1250(*1110 – 1350*)	1220(*1060 – 1290*)	1250	1240	1240	–	–	–
Modulus of rupture (N/mm²)	12.9(*11.2 – 13.0*)	10.4(*7.3 – 13.3*)	10.3(*6.3 – 12.8*)	10.1	10.5	18.3	13.8	17.0	19.0
Modulus of elasticity (N/mm²)	5360(*4920 – 6390*)	4940(*4240 – 5760*)	4890(*2860 – 6600*)	4930	5110	6360	2000	2500	2750
Impact resistance (mm drop)	255(*220 – 310*)	324(*192 – 410*)	413(*254 – 538*)	304	631	321	–	525	–
Tensile strength perpendicular (N/mm²):									
new board	0.83(*0.75 – 0.87*)	0.73(*0.34 – 0.93*)	0.72(*0.36 – 1.06*)	0.60	0.72	1.25	0.34	0.5	0.5
after V313 test	–	0.49(*0.14 – 0.72*)	0.33*(*0.24 – 0.41*)	0.38	0.39	0.17	–	–	0.25
Residual swelling after V313 test (%)	–	0.62(*0.43 – 1.13*)	0.33*(*0.17 – 0.49*)	0.35	0.27	4.66	–	–	max 8
Thickness and length swelling after water soak(%):									
thickness – 1 hour	0.44(*0.34 – 0.58*)	0.73(*0.19 – 1.76*)	0.50(*0.14 – 1.47*)	0.61	0.42	1.27	max 12	max 10	max 8
thickness – 24 hour	0.66(*0.63 – 0.69*)	0.96(*0.33 – 2.10*)	0.74(*0.34 – 2.01*)	0.90	0.69	2.78	–	–	max 8
length – 1 hour	0.06(*0.04 – 0.07*)	0.07(*0.04 – 0.12*)	0.07(*0.03 – 0.11*)	0.09	0.11	0.04	–	–	–
length – 24 hour	0.08(*0.07 – 0.10*)	0.05(*0.08 – 0.12*)	0.11(*0.07 – 0.14*)	0.14	0.14	0.12	–	–	–
Thickness and length swelling after relative humidity changes from 65 to 95% rh (%):									
thickness	–	0.37**(*0.26 – 0.58*)	–	–	–	3.27	max 7	max 7	max 7
length	–	0.06**(*0.05 – 0.07*)	–	–	–	0.19	max 0.35	max 0.35	max 0.35

*only 2 consignments tested **only 3 consignments tested Figures in italics indicate the range of results

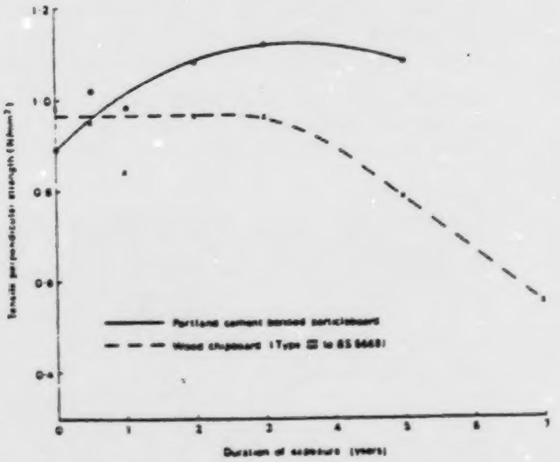

Figure 1 The change in tensile strength perpendicular to the grain (internal bond strength) of a wood cement particleboard panel and a good quality moisture resistant chipboard (Type III) exposed to natural weathering

It will be noted from Table 2 that the range of results obtained in each test was quite considerable, the upper end of the range frequently being some 40 per cent higher than the lower end and occasionally as much as 60 per cent higher. It will also be noted that the range in density is also considerable, much of this occurring between brands rather than between boards of any one brand. It is possible to account for a considerable part of the variation in strength in terms of variation in density and Figure 2 illustrates the relationship between modulus of elasticity and density. With a correlation coefficient of 0.726 this implies that about 50 per cent of the variation in modulus can be accounted for in terms of variation in density. Values of the coefficient for the various other strength properties were about 0.5 to 0.6, implying that less of the variation could be accounted for by density effects though density was still important.

The data have been depicted in Figure 2 in order to show any thickness effect, but it will be noted that there is no consistent effect of thickness on modulus of elasticity, or indeed on any strength property with the exception of impact resistance where there was a pronounced increase in strength with thickness.

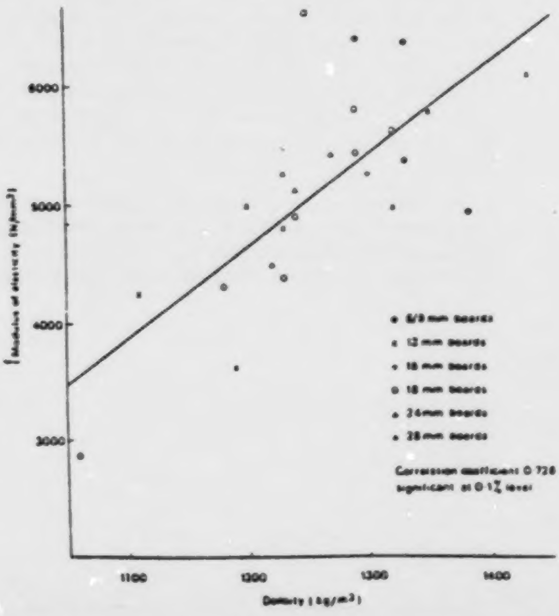

Figure 2 The effect of density variation on the modulus of elasticity (stiffness) of a wide range of wood cement particleboards of different thicknesses. Each point represents the mean of twelve samples taken from each of at least one and usually six boards

Comparing the performance of the magnesite and Portland cement bonded boards, it will be observed from Table 2 that all the strength and stiffness properties of the former are higher by up to 80 per cent: this is a direct reflection of the higher bond strengths achieved in magnesite based cements. However, magnesite cement possesses relatively low water resistance and the manufacturers of this board state that it is not suitable for external use. Our test data would certainly support this judgement as it will be noted from Table 2 that the extent of swelling in the presence of water, or under changing relative humidity, is much greater than that for the Portland cement based boards. Furthermore the magnesite board failed the V313 test, the retention in strength following exposure being very poor. This board is further characterised by having very high equilibrium moisture contents at high relative humidity: thus the magnesite board had a moisture content of 24 per cent at 90 per cent relative humidity compared with an average of 11 per cent for the Portland cement based boards. There is an indication that the equilibrium moisture contents of all the wood cement particleboards increase with time and with cyclic changes in humidity; further investigation of the moisture relationship is in hand.

One of the principal attributes of wood cement particleboards, whether Portland or magnesite cement bonded, is their excellent performance in fire tests. While this area of performance was not assessed by PRL, information is contained in the manufacturers' literature following assessment by UK fire testing laboratories. Class 1 rating is achieved in the 'Surface spread of flame' test as set out in BS 476:Part 7 (1971) and Class 0 in the 'Ignitability' and 'Fire propagation' tests in BS 476:Part 5 (1979) and Part 6 (1981). However, the product at present fails to pass the 'Non-combustibility' test of BS 476:Part 4 (1970) and AMD 2483 (1978) and in Germany is rated as category B_1 of DIN 4102 Part 1 ie 'hard to burn'. Recent developments by one manufacturer have led to the very recent production of a board satisfying the requirements of the German Category A_2 of DIN 4102, the second of two incombustibility classes. Test boards produced in the same factory and incorporating further additives have been evaluated in the UK and have met the requirements of BS 476:Part 4, ie they are 'non-combustible'. These special boards should be available towards the middle of 1983 but it should be appreciated that while offering non-combustibility, the strength properties will be lower than those of the normal board represented in Table 2.

Since its density is almost twice that of chipboard, wood cement particleboard also has excellent sound insulating properties and manufacturers claim that a 33 dB rating can be achieved from an 18 mm board. However, one drawback of the high density of the product is in its handling — an 18 mm thick board 2800 × 1250 mm weighs about 75 kg. Also, thin boards must be supported in their middle when being lifted, to avoid fracture.

APPLICATION

European experience over the last twelve years has demonstrated the successful application of wood cement particleboard for cladding, for internal wall lining and flooring where either high resistance to fire or moisture or both is specified, agricultural use (especially stock rearing pens), and for sound absorption barriers. More recently with its introduction to the UK, additional applications have been identified such as fire doors, ventilation ducts and refuse shafts, fire resistant stiffening for GRP panels, and soffits.

Machining of the boards necessitates the use of tungsten-carbide tipped saws or diamond impregnated blades with fine teeth and a low set, together with an efficient dust extraction system. Tool wear, somewhat surprisingly, has been reported as being considerably lower for the cement boards than for wood chipboard.

Panels can be bonded to themselves, or to wood using alkali compatible adhesives such as resorcinol formaldehyde, or under less arduous exposure conditions, a catalysed polyvinyl acetate. They can also be bonded to metal using resorcinol formaldehyde and appropriate primer, and to brickwork using resorcinol formaldehyde alone.

Adjacent boards can also be mechanically fixed using nails or screws, but it is necessary in boards greater in thickness than 6 mm to drill pilot holes for both screw and nail fixing. HSS steel drill bits should be used and the minimum distance of the hole from the edge is generally about 25 mm.

Paints and plasters applied in finishing must be alkali resistant otherwise the surface of the board must be suitably primed using, for example, a chlorinated rubber paint.

CONCLUSIONS

Wood-cement particleboard should not be regarded as a competitor or replacement for wood chipboard: rather it should be viewed as a means of extending the range of applications of particleboards, in particular into areas where either moisture or fire risk preclude the use of other types. Its principal attributes are undoubtedly its durability, its relative incombustibility, and its stability; it is unlikely that the high density, low impact and lower bending strength are serious drawbacks to what promises to be a most important panel product. It has already established itself in the UK for specific end uses and there is no technical reason why its usage should not continue to grow.

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APPENDIX IV

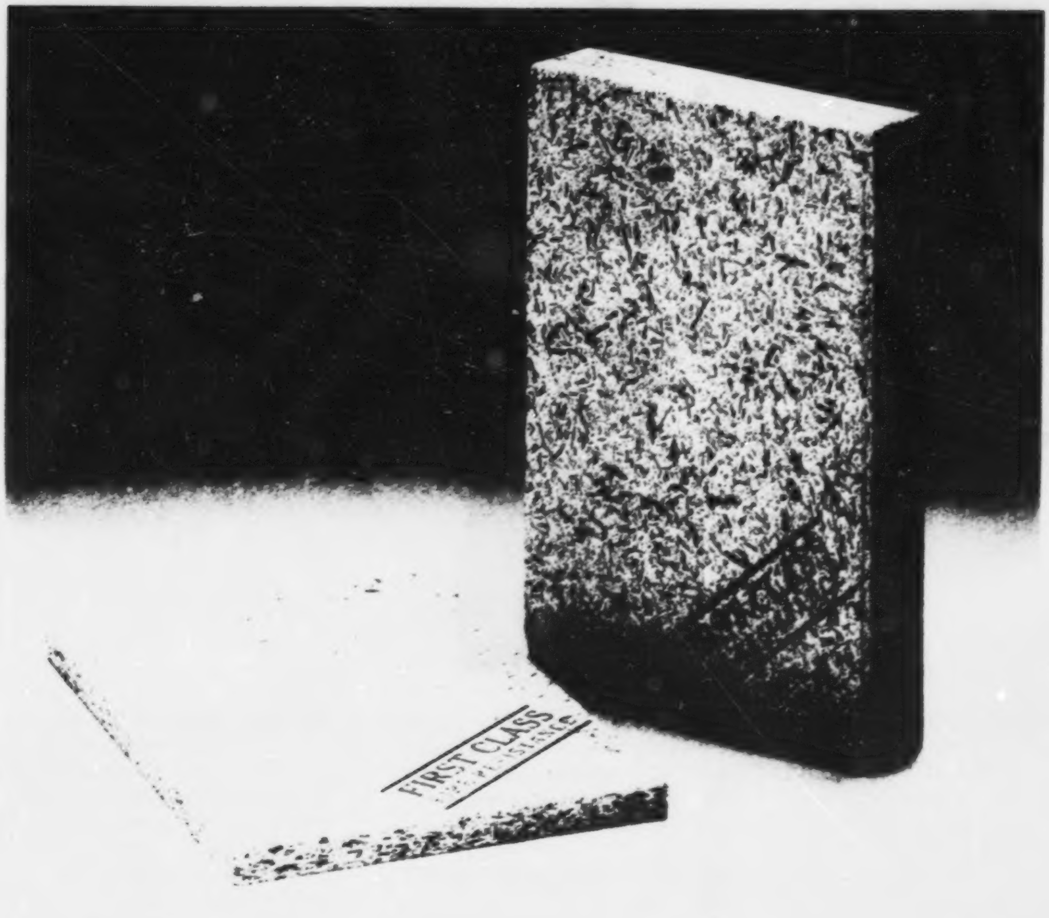
CEMENT BOARD TECHNICAL DATA - MACHINERY SOURCES

1. The Ecocem Process
2. Rauma-Repola

The Ecocem* Process

* patented

for fast and economic production of cement bonded particleboard

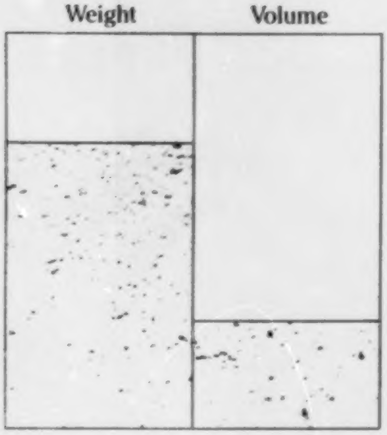


Raute Particleboard Technology

RAUTE

Ecocem – a building board with the best properties of wood ar

What is Ecocem?
Ecocem is a building board manufactured from wood particles and a special cement made from blast-furnace slag from the steel industry. The particles, cement, activators and water are blended together and pressed to form a board, the density of which is about 1300 kg/m³. By weight the board is 30 % wood and 70 % cement, while by volume wood represents 70 % and cement 30 %.



The advantages of Ecocem:

- excellent fire resistance
- good sound insulation
- good mechanical strength and resistance to impact
- does not contain asbestos, formaldehyde or other hazardous materials
- rot and insect resistant
- moisture resistant

The best properties of wood and cement in the same board

The best properties of both wood and cement are combined in Ecocem. Even when surfaced, the board is fire resistant and inhibits spread of flame. Ecocem is strong, impact resistant and has good sound insulating properties. It does not contain asbestos, formaldehyde or other hazardous materials. Ecocem is rot and insect resistant and can be used in both cold and damp environments – when surfaced, it is even suitable for external use.

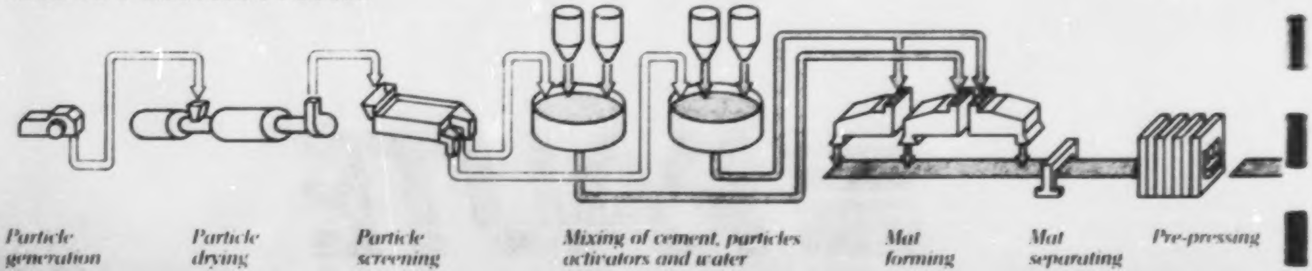
Ecocem is not in direct competition with conventional particleboard; rather its properties extend the range of applications for wood-based panels in building.

Fulfills even the most exacting demands

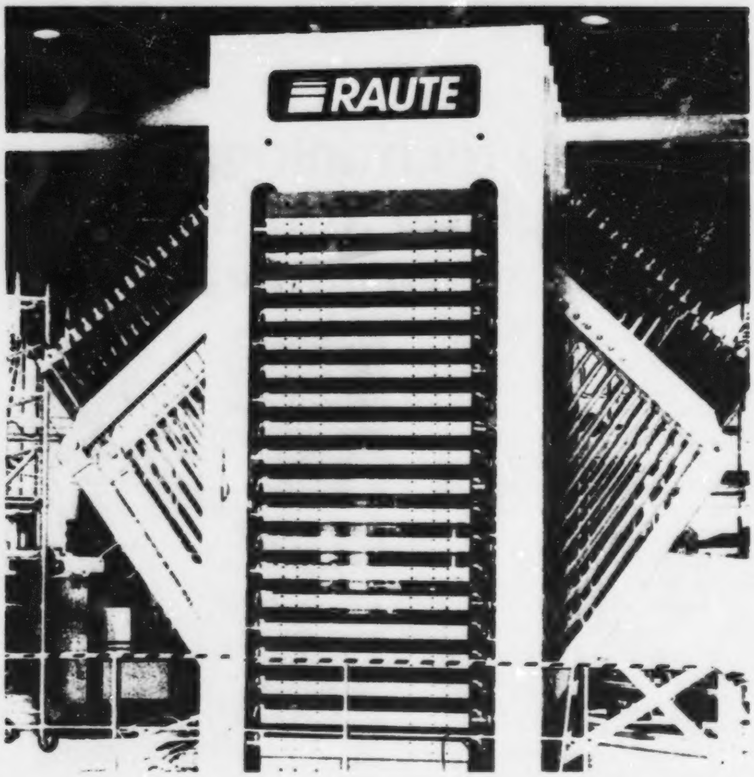
Ecocem can be used wherever tough demands for fire safety, strength or sound insulation are imposed; when the fire resistance of conventional particleboard or the moisture resistance and strength of plasterboard are not sufficient.

The applications for Ecocem include industrial buildings and warehouses, schools, nurseries, and other public buildings, dwelling and business places, boiler rooms and farm buildings. In these places Ecocem can be used from floor to ceiling. Ecocem allows the use of real wood in public buildings, because when surfaced with veneer the fire safety properties of the board are not affected. In pre-finished form the applications for Ecocem extend from public meeting places and hotels to sports halls and offices.

RAUTE's Ecocem Process



d cement



The advantages of the Ecocem Process:

- both softwoods and hardwoods can be used as the raw material
- the wood raw material does not need to be stored or preconditioned
- blastfurnace slag – the bonding agent – is a by-product and therefore cheap to acquire
- the process is rapid thanks to the hot pressing of the product
- separate curing of semi-finished products is not required

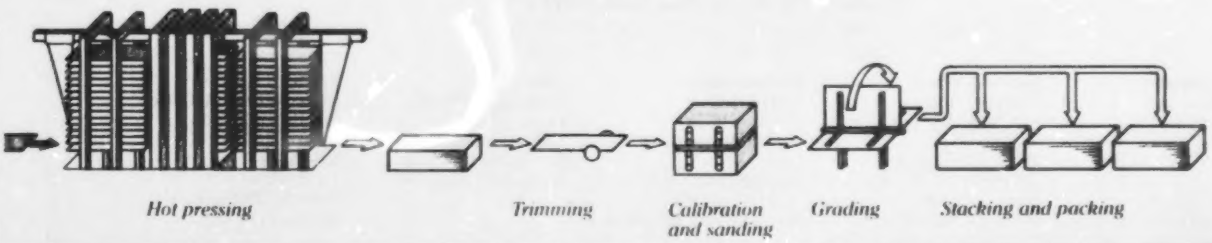
Simple and economic manufacturing process
Almost all wood species which can be used in the manufacture of conventional particleboard are also suitable for Ecocem. Blastfurnace slag – the bonding agent – is not sensitive to the effects of water-soluble sugars and extracts contained in some wood species, so that hardwoods are also suitable as the raw material.

Granulated blastfurnace slag is a by-product of the steel industry and as such is widely available. According to local circumstances, the slag may be acquired ready milled or it may be milled by oneself.

The activators used – sodium hydroxide and sodium silicate – are widely used general industrial chemicals.

The Ecocem process is generally quite same as that used for the manufacture of conventional particleboard. The wood raw material is chipped, dried and screened. The particles are combined with the cement, activators and the necessary extra water in a blender. The particle mat is prepared with a former, pre-pressed and then transported into a multi-opening hot press. Pressing time, depending on board thickness, is 8–18 min. After pressing, the boards are trimmed, sanded on both sides and graded.

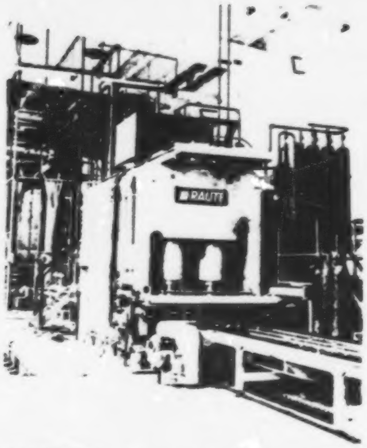
The Ecocem process has been operating in Finland since autumn 1985. Patents have been granted in Finland for both the product and the process and applications have been made in 30 other countries.



The properties of Ecocem

Density	1200–1400 kg/m^3
Modulus of rupture	10–14 N/mm^2
Modulus of elasticity in bending	4000–5000 N/mm^2
Internal bond	0.3–0.6 N/mm^2
Swell in thickness (24 h)	2–3 %
Linear expansion (35–90 % RH)	0.2 %
Surface pH	11

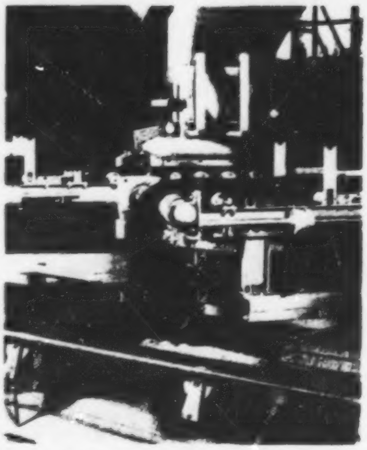
Wood processing technology and expertise in weighing and dosing techniques in the same organization



RAUTE's Wood Processing Machinery Division – expert in mechanical wood processing technology.

RAUTE is known worldwide as an expert in mechanical wood processing technology. In the seventy-five years of its history RAUTE has supplied innumerable lines and machines to the plywood, particleboard and timber processing industries of more than 50 countries throughout the world.

For Ecocem, RAUTE's own expertise is complemented by the know-how of the organization's Automation Division. This division's area of special expertise is materials handling and automation. Its weighing, dosing and process control techniques are, amongst others, used in the concrete industry. These same techniques are exploited to great advantage in the Ecocem process.



RAUTE's Automation Division – expert in materials handling and automation.

The RAUTE Corporation

The RAUTE Corporation is an international, multi-discipline organization whose fields of operation are wood processing machinery, automation and furnishing. The Corporation has production facilities in Finland, Canada and USA and sales offices in South America, USA, Southeast Asia and Sweden. The RAUTE Corporation employs some 1400 persons and about 80 % of its output is exported.

RAUTE

WOOD PROCESSING MACHINERY

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RAUMA-REPOLA
LOVIISA
ENGINEERING
WORKS

FOR THE WOOD-BASED PANEL INDUSTRY RAUMA-REPOLA HAS ALL THE ANSWERS

Rauma-Repola Oy Loviisa Engineering Works, Valko, Finland.

The Rauma-Repola Group is a diversified, major Finnish enterprise operating in the metal and forest products industries. Activities are based on the sea and the forest, in both of which Rauma-Repola has long been renowned for its know-how.

In the forest sector it means devoting ourselves to building the machines and equipment required for wood processing, and to maintaining a high level of timber harvesting and processing. These areas have excellent prospects for growth and development, and they offer great scope for the application of high technology.

THE BUSINESS AREAS OF RAUMA-REPOLA ARE:

- Engineering Industry
- Mechanical Woodworking Industry
- Pulp and Paper Industry
- Shipbuilding and Offshore Industry

Rauma-Repola operates in 40 locations in Finland and abroad and has marketing companies in 16 countries.

LOVIISA ENGINEERING WORKS

The business idea of Loviisa Engineering Works is to help the wood based panel industry to manufacture competitive products. In practice the business idea is realized by developing, marketing and manufacturing advanced plants, production lines and individual machines for the world's wood based panel industry. The business operations of Loviisa are based on total mastery of project management. The expertise of the personnel is shown in deliveries of complete, custom-designed mills and plants. Apart from the machinery the delivery may comprise engineering, procurement, installation supervision, training of personnel and start-up of the plant.

The most important products of Loviisa Engineering Works are machinery for:

- particle board
- oriented strand board
- waferboard
- laminated veneer lumber
- plywood and
- surface overlaying plants

Together with the subsidiary Kährs Maskiner AB of Sweden, Loviisa Engineering Works also offers its customer complete plants for parquet and house manufacturing. With another subsidiary, Raumatic Oy, operations furthermore cover the panel handling and finishing.

Rauma-Repola stands firmly behind Loviisa Engineering Works, providing additional technical and financial support for comprehensive service to the wood-based panel industry.

If your needs are a new production plant, modernization of an existing one or individual machines, Rauma-Repola is the right partner for you.

RESEARCH & DEVELOPMENT

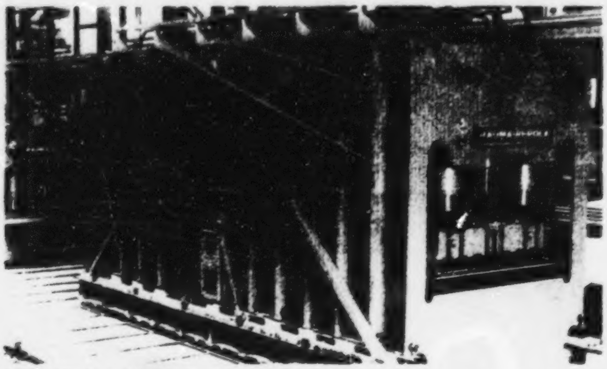
The product development aim of Loviisa Engineering Works is to guarantee customers the availability of highly advanced products today and in the future. The development of the best solutions for customers requires utilizing a broad range of technical knowledge, experience and experiments.

In the development process, the expertice of our own personnel is combined with the resources of outside development and research organizations.

The large volume of Rauma-Repola's own mechanical wood processing industry offers a good testing ground for Loviisa Engineering Works' new products, thus ensuring that they fulfil the high technical, commercial and reliability targets as soon as they appear on the market.

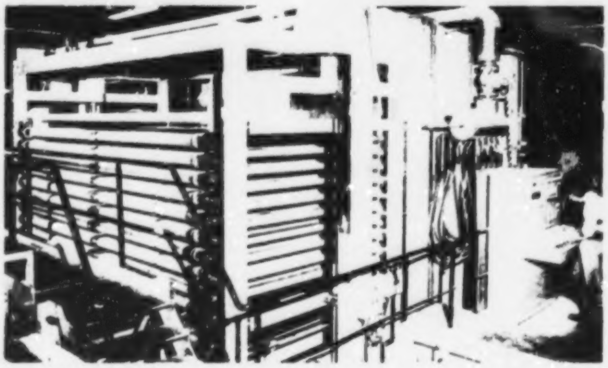
Rauma-Repola Oy Loviisa Engineering Works offers advanced ma
Special emphasis has been placed on the high technica

PARTICLE BOARD
Rauma-Repola's particle board production line is characterized by high product quality and total reliability of the machinery. With Rauma-Repola machinery, board can be made from roundwood, shavings and a wide variety of wood waste materials. For particle board production, Rauma-Repola's own machinery covers all the main machinery needed for a complete production line

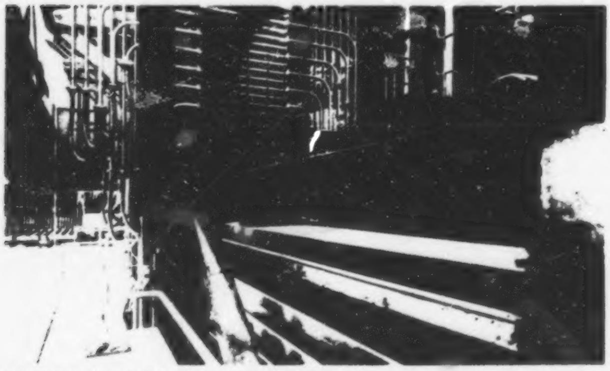


STRUCTURAL BOARDS
Rauma-Repola supplies complete plants for the production of Oriented Strand Board, Waferboard and Flakeboard. The production of oversized panels on Rauma-Repola's custom-designed presses is another creative application of the company's structural board technology.

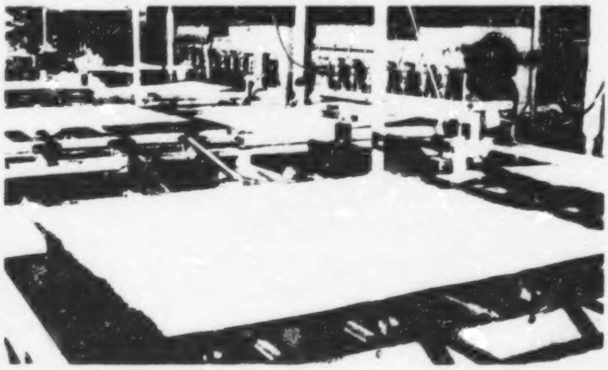
PAPER IMPREGNATING
Rauma-Repola's impregnating plants are well suited for impregnating decorating and single-colour papers for finishing wood panels. The accent so far has been on phenolic and melamin overlays



BOARD OVERLAYING
Rauma-Repola has developed a special high-speed single-opening overlay-ing press line. This type of line is mainly used for overlaying furniture quality boards. For plywood overlaying with phenolic film in multi-opening press lines, Rauma-Repola has designed an automatic overlay setting system



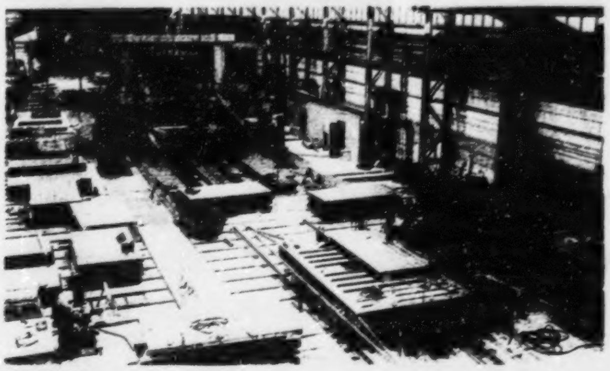
MINERAL BONDED PARTICLE BOARDS
A unique press line has been developed for mineral bonded particle boards like cement and gypsum boards. Rauma-Repola's production process is pollution-free, simple and space saving



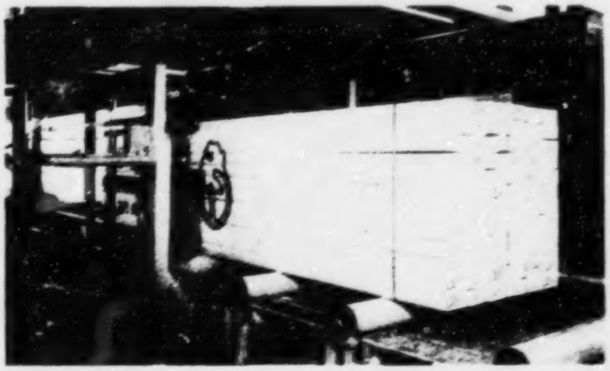
LAMINATED VENEER LUMBER
Significant for the Rauma-Repola LVL process is that veneers are scarf-jointed to full length sheets. This guarantees 100 % quality of the joints and eliminates faulty lay-up. The sheets are automatically laid up to form planks of required thicknesses. Also, shorter planks than nominal can be pressed, thus enabling planks to be cut without leftovers to all customer specified lengths. Rauma-Repola specializes in high capacity LVL production lines

WOOD-BASED PANEL INDUSTRY

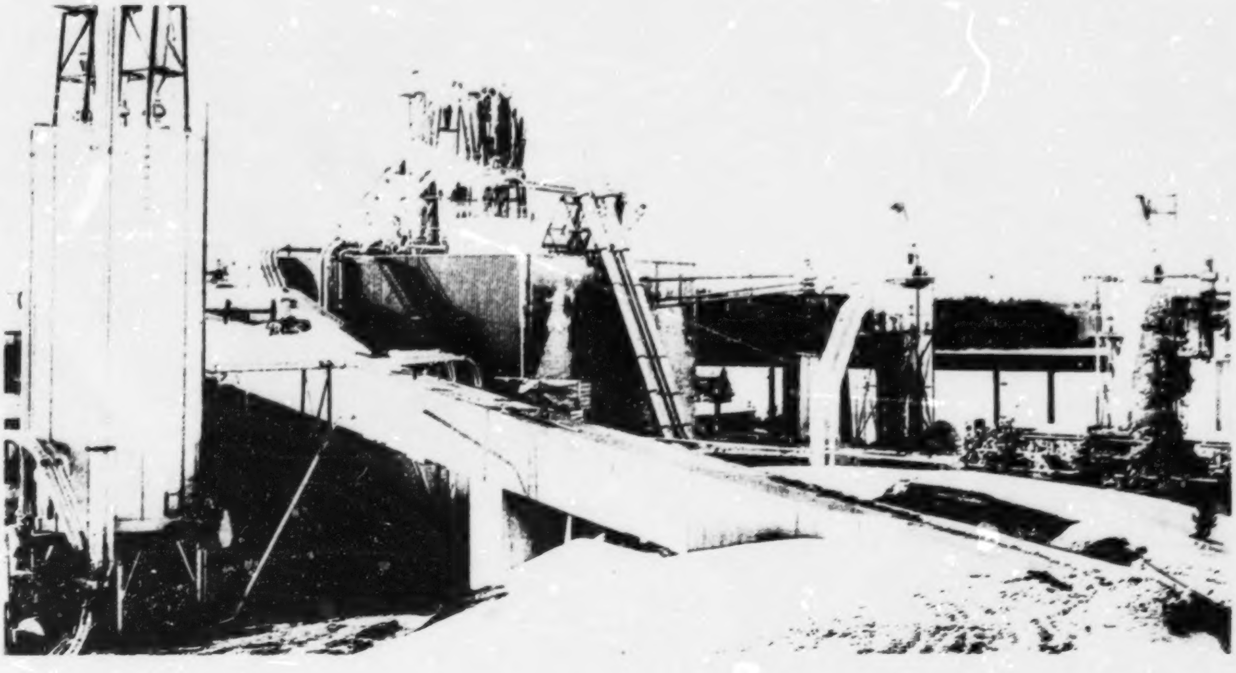
chinery and equipment for the world's wood-based panel industry.
level, reliability and easy maintenance of the machinery.



PRESSING
Loviisa Engineering Works has invested heavily on the development of presses and pressing technology. The manufacturing equipment at the workshop represents the latest technical requirements and performance. Rauma-Repola presses are known as the most rugged and reliable units available on the market.



OTHER PRODUCTS
The Rauma-Repola marking robot marks your lumber and panel packages automatically. This highly advanced computercontrolled robot saves your labour and paint costs.

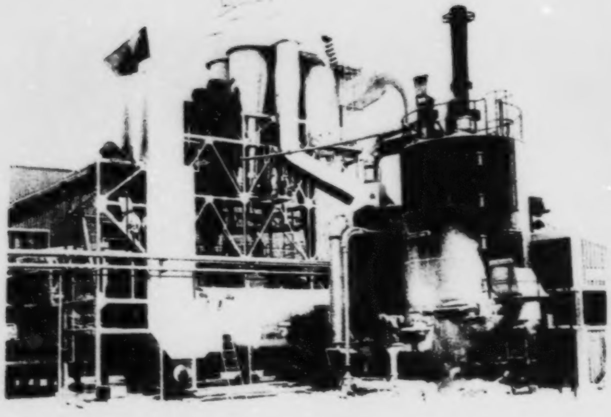


SERVICES FROM RAUMA-REPOLA

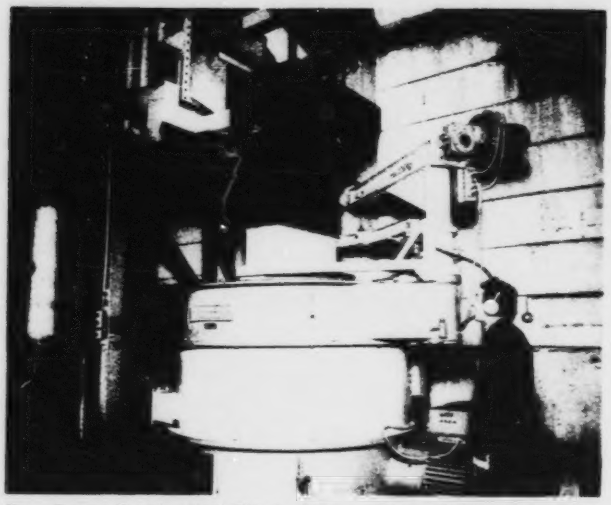
As a company deeply involved in both wood processing and the manufacture of wood-processing machinery, Rauma-Repola has accumulated a wealth of experience, and is thus able to offer a full range of services for its customers:

- process design
- plant engineering
- supply of machinery and equipment
- erection or erection supervision
- start-up
- training of personnel
- after-sale services

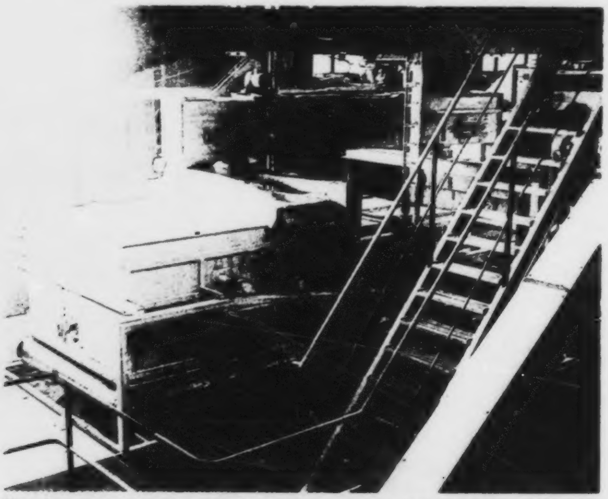
RAUMA-REPOLA FLAK



High quality board can only be made using proper flaking and refining methods, and fully controlled drying conditions. Stabilizing the mixture of various materials is one of the difficult parts of the process. Rauma-Repola supplies not only the machines but also the sophisticated engineering required.

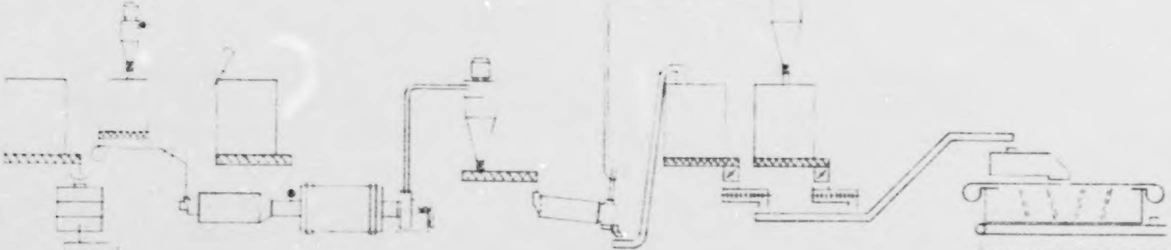


The Rauma-Repola Verti-Flaker R-R produces flakes of roundwood flake quality from chips and wood waste. It also features low flaking energy consumption, and low knife and maintenance costs.

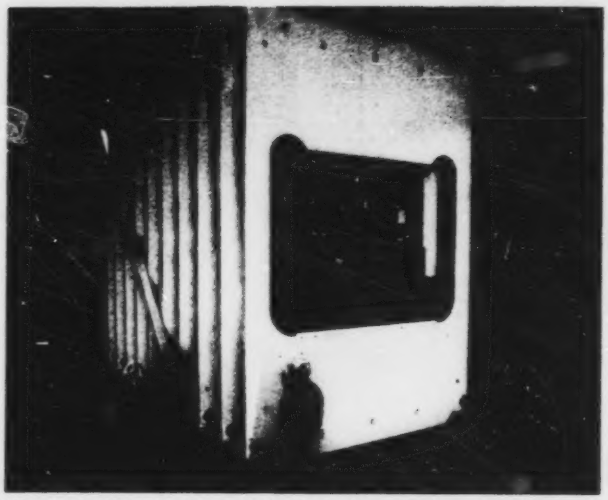


The forming station is designed to produce board of the desired structure and properites. As an experienced producer of various forming machines, Rauma-Repola has all the know-how necessary for the right forming concept.

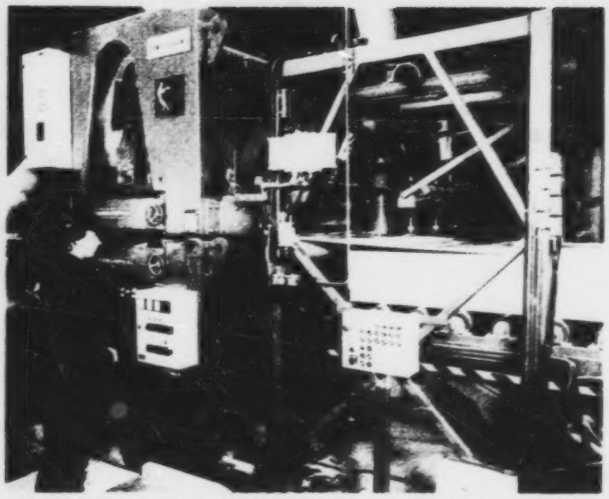
RAUMA-REPOLA FLAKEBOARD PRODUCTION LINE



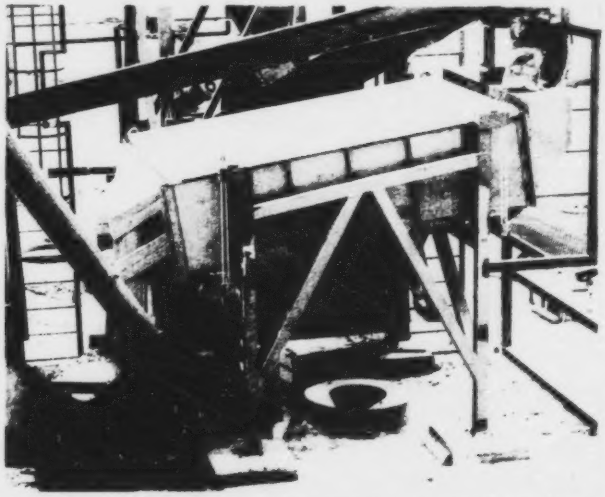
EBOARD MACHINERY



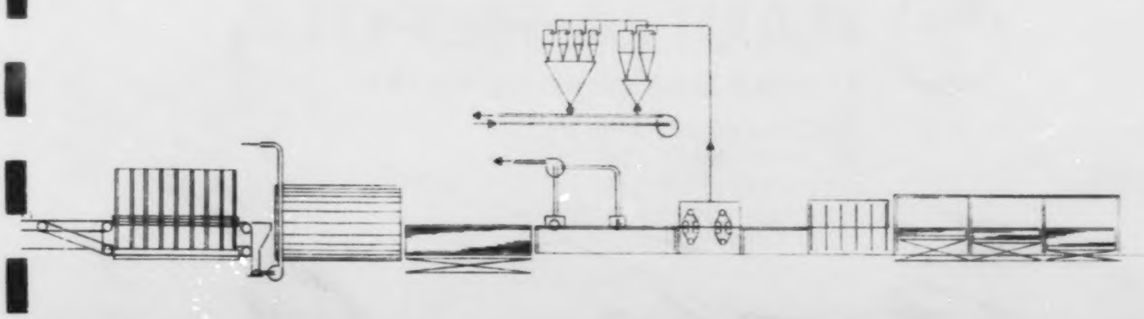
Board properties such as strength, surface hardness, quality and sanding tolerance are highly dependent on pressing techniques. Rauma-Repola offers a wide range of custom designed single and multi-opening presses for various applications.



The ultimate quality of finished board also depends on proper sanding done with a sturdy and reliable sander like the Rauma-Repola 'Timesavers' wide belt sander.



Since the raw material comprises mainly wood waste and other residues, effective classification is essential in order to obtain the correct distribution of particles within the board. Rauma-Repola makes both mechanical screens and air classifiers.



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APPENDIX V

MATERIAL SPECS FOR GYPSUM FIBREBOARDS

RAW MATERIAL SPECIFICATION

for SIEMPELKAMP Gypsum fiber board plants

1. Plaster of Paris

- Purity min.:		85	%
- Modulus of rupture of dry body at a water-plaster ratio of 0,71:	> =	35	kp/cm2
- Feed quantity into 100 cm3 H20:	=	140	g
- Initial setting:		8 - 25	min.
- Compressive strength dry at a water-plaster ratio of 0,71:	> =	85	kp/cm2
- Residual dihydrate content:	< =	1,5	%
- Residual crystallization content approx.:		5	%
- Bulk density acc. to Böhme approx.:	=	780	g/l
- Fineness of grain:			
Residue on screen 0,063:	<	20 - 30	%
Residue on screen on 0,2:	=	5	%
- supplied temperature max.:		50	°C

Tests as per DIN 1168 except modulus of rupture and compressive strength because of the constant water-plaster ratio of 0.71 and humidity storage of 24 hours.

2. Paper:

- 99,5 % newspapers and magazines, proportion 60 : 40,
- max. 0,5 % pollution as sand, dust, strings. Metallic objects, plastic material and organic greases (food particles) have to be avoided.

3. Production water

Hardness : max. 30 dH
pH-value : 6 - 7.5
sulfate contents : max. up to saturation with calcium dihydrate
quality : free of organic and phytogenic residues

4. Coating agent:

Mixture consisting of:

- 6 portions of Silicone masonry water repellent BS 15
  (aqueous solution of potassium methyl siliconate)

- 1 portion Vinnapas-dispersion SAF 54
  (syrene acrylate copolymer dispersion
  50% solid content)

The aforementioned materials are produced by Messrs. Wacker-Chemie GmbH, 8 Munich 22 / West Germany. The mixture must be diluted with water.

5. Monohydrate (citric acid C6H8O7+H2O)

Crystalline material chemically pure.
Monohydrate has to be diluted with water.

APPROXIMATE CONSUMPTION FIGURES

Based on the following parameters:

- thickness of finished board	10 mm
- density of finished board	1,180 Kg/m3
- finished board size	1,220 x 2,440 mm

- based on reprocessing of waste material in a calcining plant

Material required per square meter of finished board based on nominal composition of 18% waste paper fibers, 80% plaster of Paris, 2% accelerator.

1.	Waste fibers dry - approx.	1.9 Kg.
2.	Plaster of Paris plus accelerator - approx.	8.7 Kg.
3.	Water - reusing pressed water after clarification	6 liters
4.	Coating Agent	
	BS 15	28-40 grams
	SAF 54	7-10 grams
5.	Monohydrate	2-3 grams
6.	Electric energy	1.3 Kwh/m2
7.	Heat energy for drier	4,000 Kcal/m2

Siempelkamp

Plants for the Production of Gypsum Fiber Board

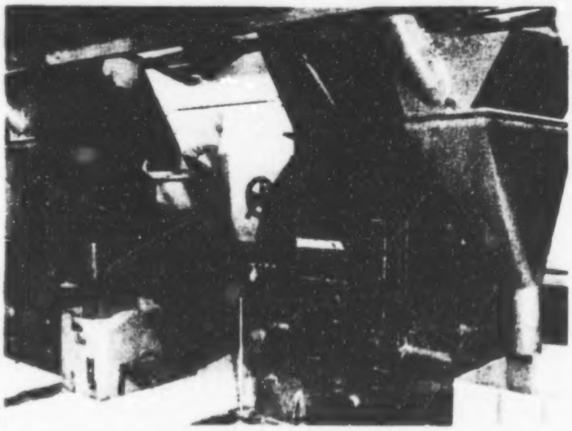
Raw Material Preparation

During the last decade, special technologies and the machine techniques have been directed towards the gypsum industry resulting in a new highly valuable building material, gypsum fiber board. Its excellent physical properties and easy workability have made it a success in the market place.

The raw materials for gypsum fiber board are gypsum, cellulose fibers, and water, all of which are non-toxic and absolutely harmless to manufacturing and installation personnel. These ecological advantages will continue to enhance the market potential for gypsum fiber board in the future. Additionally, these raw materials are generally plentiful in all countries of the world.

Gypsum is a mineral, chemically indentified as dehydrate of calcium sulfate ($CaSO_4 2H_2O$) which partially dehydrates when it is subjected to heat and, in this manner, becomes the universally known plaster of Paris. This semihydrate of calcium sulfate is the basic raw material of gypsum fiber board. The cellulose fiber component of the product is produced from waste paper. The homogeneous distribution of the paper fiber within the plaster of Paris produces the necessary reinforcement which provides the boards with their superior strength values.

Siempelkamp supplies completely mechanized and automated plants for the production of gypsum fiber board. Currently the most popular product dimensions are 1,000 × 1,500 mm for the do-it-yourself market and 1,250 mm width with a length from 2,500 to 3,600 mm for the building industry. Panels are also produced in a size of 2,500 × 6,000 mm for use in prefabricated houses. The most common board thickness is 10 mm, however, 12,5-15 and 18 mm thicknesses can also be produced.



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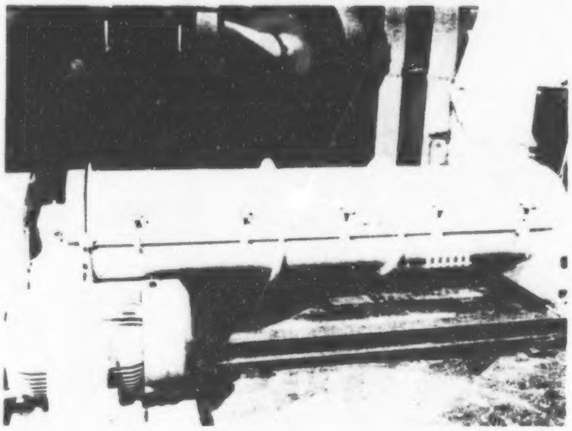

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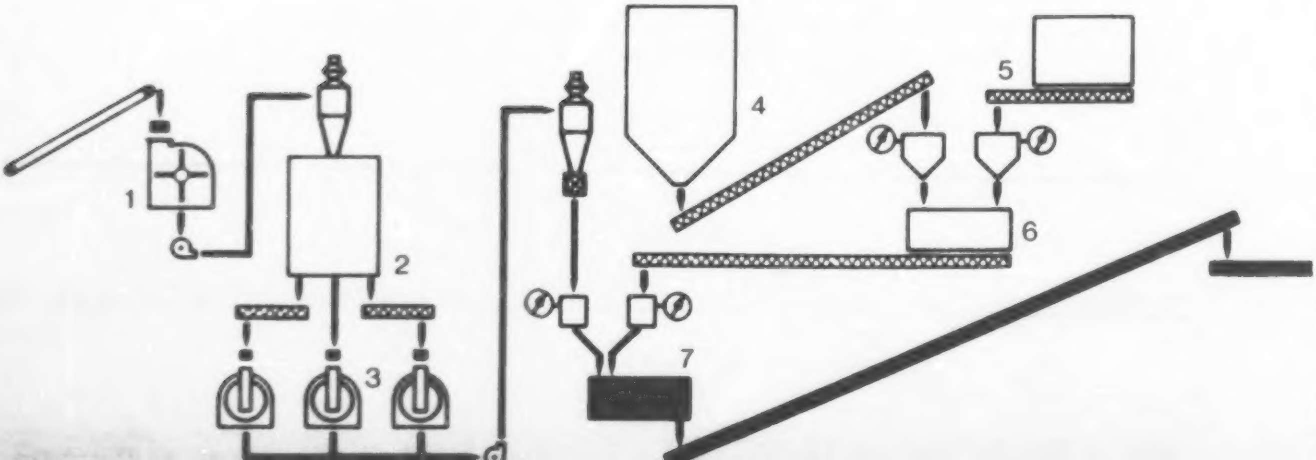
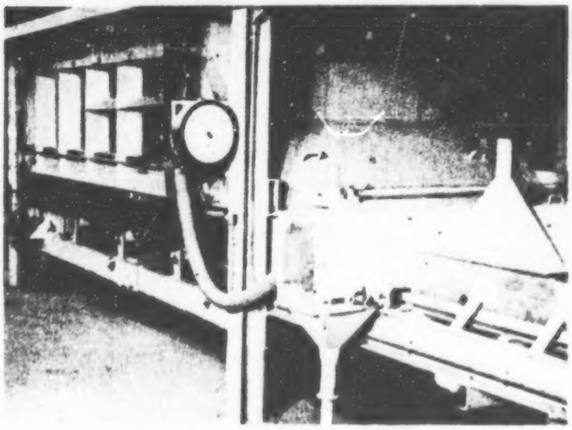
The cellulose fibers are most frequently produced from waste paper such as newspapers and magazines.

In the first step, clippings of about the size of a postage stamp are produced. These are subsequently refined into cellulosic fibers. The fibers are mixed with plaster of Paris and with a small quantity of sanding dust (dihydrate) which acts as an accelerator.



Pressing, Drying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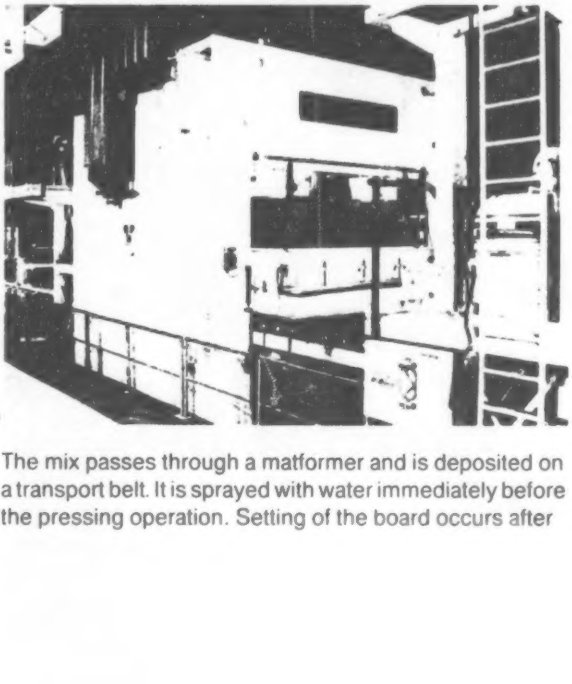
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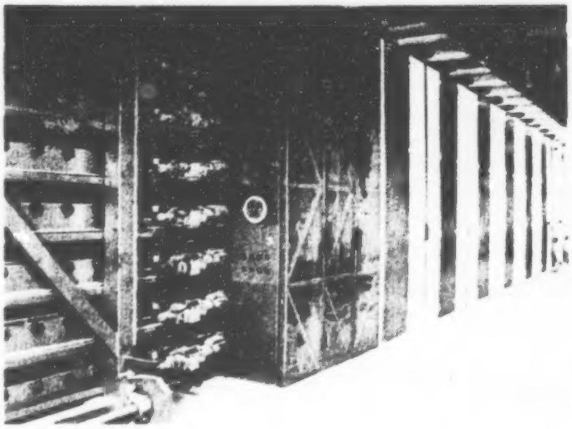
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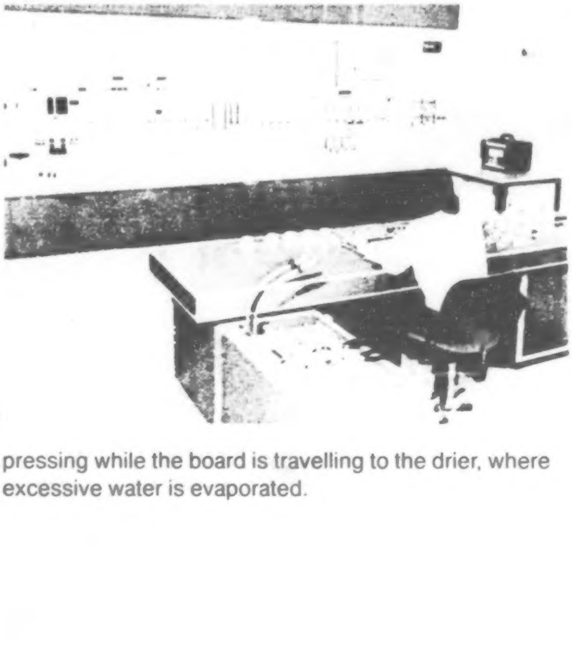
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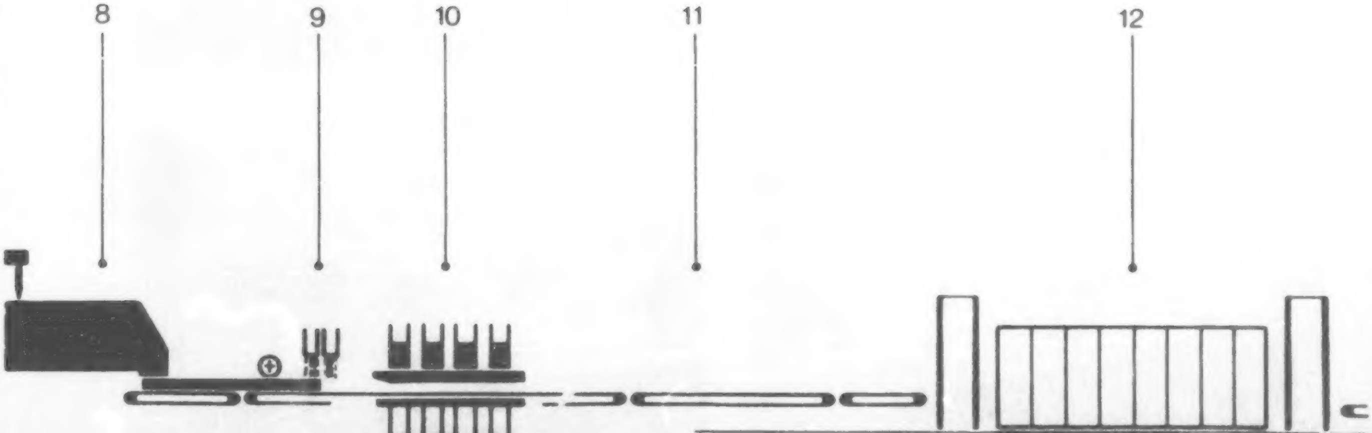
The mix passes through a matformer and is deposited on a transport belt. It is sprayed with water immediately before the pressing operation. Setting of the board occurs after pressing while the board is travelling to the drier, where excessive water is evaporated.



Siempelkamp

We provide engineering and supply complete plants, presses and other machinery for the following products:

Particle Board:
plants with single-or multi-opening presses, special plants for thin boards based on various wood species and annual plants like bagasse, casava etc.

MDF:
complete plants with or without R. F. heating

Cement Particleboard
complete production plants

OSB:
production lines with perfect strand orientation

Waferboard:
complete production plants

Fibre Board:
dry and wet process lines

Plywood:
complete plants, systems and presses for plywood, blockboard, doors and veneering of particle board

as well as:
For Surface Laminating:
single-opening short-cycle laminating plants for application of foils and films on panels and boards

For all panel-type products:
finishing lines, sorting and handling systems, stacking and storage systems

G. Siempelkamp GmbH & Co.
Maschinen- und Anlagenbau
Siempelkampstraße 75
D-4150 Krefeld
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Telex 0853811

Siempelkamp Corporation
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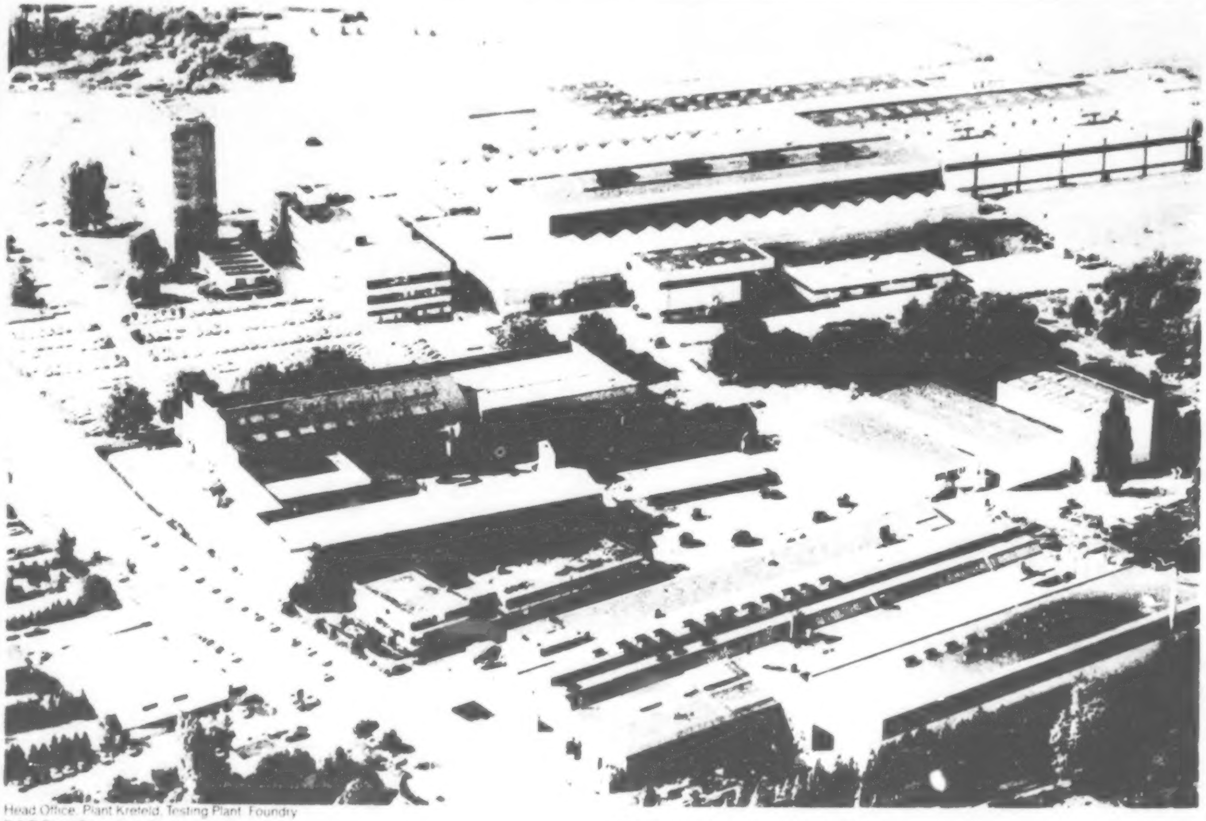
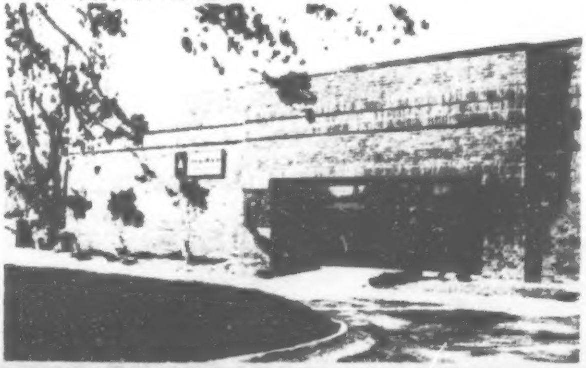
Marietta, Georgia 30067
USA
Tel. 404/9551100
Telex 0542150

Germapore Pte. Ltd.
16-23 International Plaza
10 Anson Road
Singapore 0207
Tel. 2233168
Telex 33563

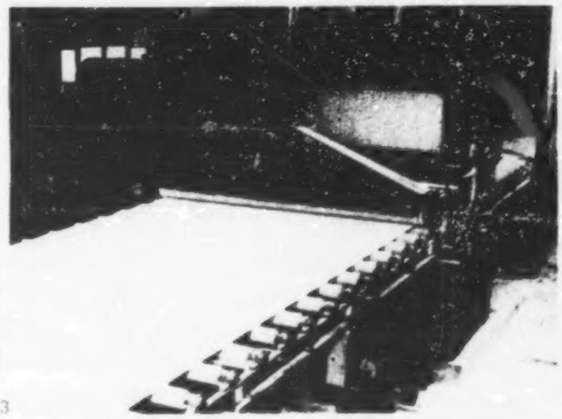


Head Office, Plant Krefeld, Testing Plant, Foundry
R & D Panel Products Laboratory

Siempelkamp Corporation, Marietta, USA



Board Finishing and Packing



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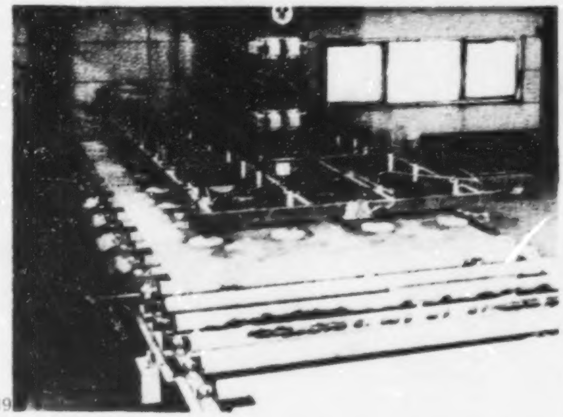

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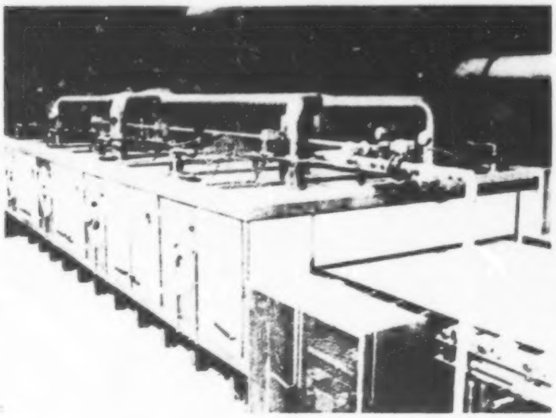

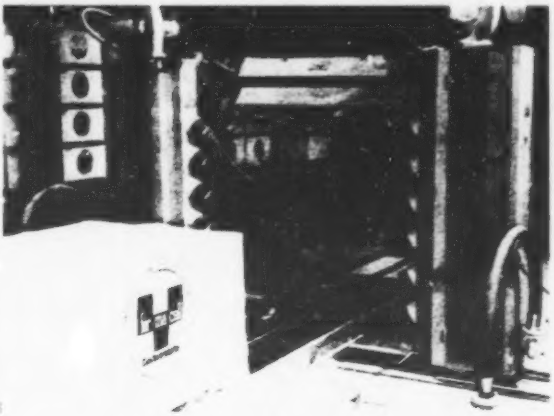

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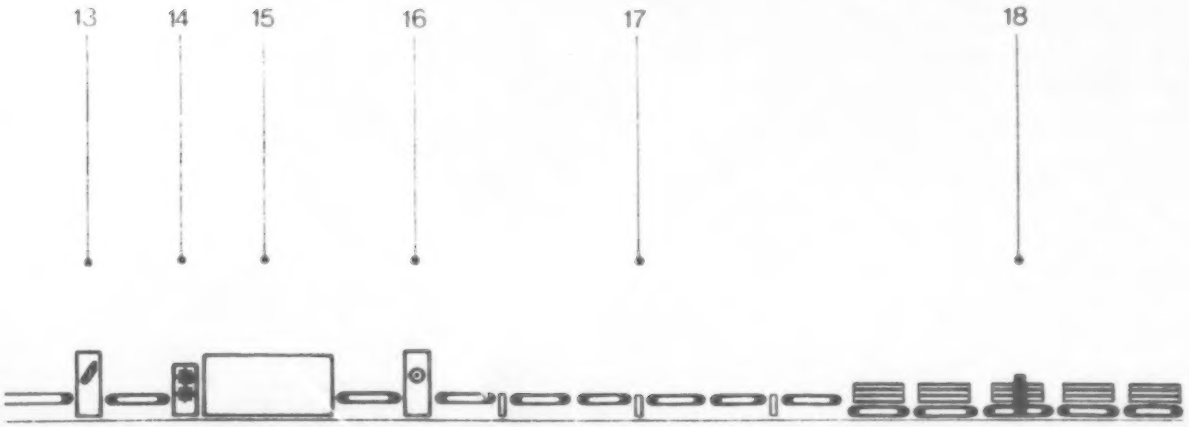
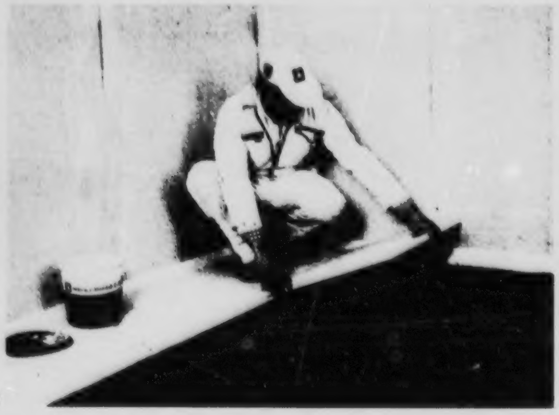
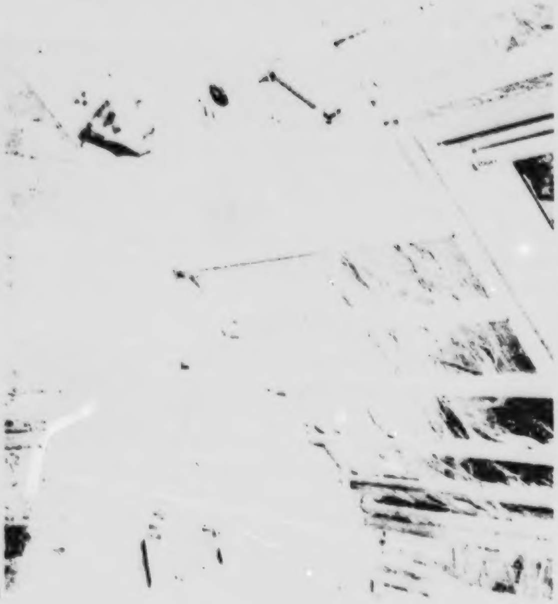
The top surface of the board may be sanded if desired, subsequently the surfaces can also be given a dust entrapping coating, which also serves to reduce water absorption. At the end of the production line the board is stacked and the stack encapsulated with foil.

1 Waste paper clipping with pneumatic conveyor
2 Clippings bunker with discharge unit
3 Paper fibrizing mill with magnetic separators
4 Silo with metering screw for plaster of Paris
5 Sanding dust silo with discharge unit
6 Mixer with weight control system
7 Mixer with metering system for fibers
8 Matformer
9 Pre-compressor and water spray unit
10 Single opening travelling press
11 Longitudinal pre-trimmer and setting section
12 Drier with loading and unloading units
13 Sander
14 Coating equipment
15 Secondary drier
16 Saw combination
17 Stacking systems
18 Compacting for foil wrapping of stacks
19 Vacuum hoist
20 Central control room



Applications of Gypsum Fiber Board





Gypsum fiber board finds many applications in the modern building industry. Due to its easy handling and processing characteristics it is suitable for processing on an industrial scale or by experts. It also provides the hobby worker with a material without comparison. This explains its suitability for universal purpose applications in dry interior finish construction. The use of gypsum fiber board is greatly enhanced by its excellent characteristics for sound absorption, heat conductivity, breathing, and its classification as a non combustible building material of class A2 according to DIN-standard 4102. It is qualified for:

- Dry linings of walls and ceilings
- Light-weight partition walls
- Suspended ceilings
- Dry flooring elements
- Composite, synthetic foam coated panels
- Building elements for prefabricated houses
- Attics
- Renovating of old houses

1 Dry flooring elements
2 Gypsum Fiber Board in damp areas

APPENDIX VI

G.F.P. - MILL OPERATIONS ARTICLE

Gypsum fiberboard proves success for Germany's Fels-Werke

This mineral/cellulosic fiber panel was a "natural" in the product diversification program of Fels-Werke, which is a leading firm in lime, expanded concrete blocks, gravel, and roadbuilding and related materials. Seeing that it would fill a market niche for a higher-value product, they built it up and made it a success. Ward Williams visited Fels-Werke recently and reports.

DUE TO ITS MANY USEFUL properties, Fels-Werke's "Fermacell" gypsum fiberboard has become a building material which has gained a significant market in Germany and in a number of other countries. Their main plant is located in Seesen, Lower Saxony, in the foothills of the Harz Mountains, about one hour's drive southeast from Hannover, and very close to the frontier between East and West Germany.

Gypsum fiberboard has come into greater prominence of late as a member of the wood based panel "family" since it contains about one fifth cellulose, the rest being gypsum and water. When used to its best advantage as an engineered product, GFB has much to offer to the housing and interior decoration sector of the construction industry. Our report, therefore, touches both on the manufacture and the application of this interesting product.

Complete line

The plant was built in the early '80s and was put up in 18 months at a cost of about $15 million, or $25 million when all the infrastructure is counted. Siempelkamp developed with Fels-Werke the whole technology and equipment involved and supplied the complete line of machinery and equipment.

Designed capacity is 7.5-8 million m^2 (80 million ft^2) per year on the basis of three shifts, 250 days, or 30,000 m^2/day (320,000 ft^2/day). During the day of WBPI's visit, Fels-Werke turned out 40,000 m^2 (430,000 ft^2).

Although it was the first of its relatively large size, the plant had no startup problems. After the first six months, a 2-shift operation was begun. This was advanced to three shifts within 18 months.

The work force numbers 72, including 5 operators and 1 foreman for the line and 10 overall per shift, plus technicians, lab chief and personnel, and relief workers. There are six professionals including one dr-chemist, lab leader, and chemical engineer.

There are no recruiting problems, as skilled workers are readily available in the district.

Plant Manager Willi Petersen has been in the gypsum fiberboard business for 12 years.

R&D work on the process was conducted at the Krefeld laboratory of Siempelkamp and at other Fels mills.

Daughter of Salzgitter

Fels-Werke is a wholly owned subsidiary of Salzgitter, one of Europe's largest industrial enterprises with sales of $25 billion and employing 60,000.

Fels-Werke has three GFB plants: the main mill at Seesen (the newest, which is described here), at Salzgitter, and near Heilbronn, the latter two being pilot plants each with a capacity one fourth that of Seesen. There is only one other GFB mill in Germany, a small plant run by a wallboard mill.

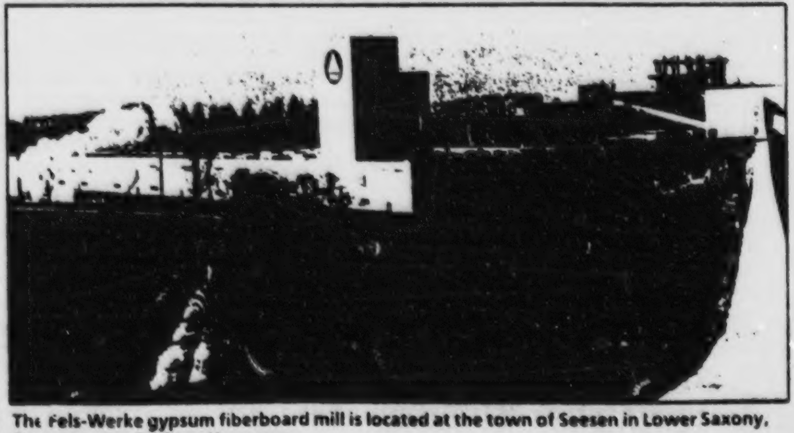
Company turnover is about $100 million at today's exchange rates, of which about $30 million is contributed by Fermacell sales. The company employs ca 1,000.

Worldwide — a growing industry — GFB

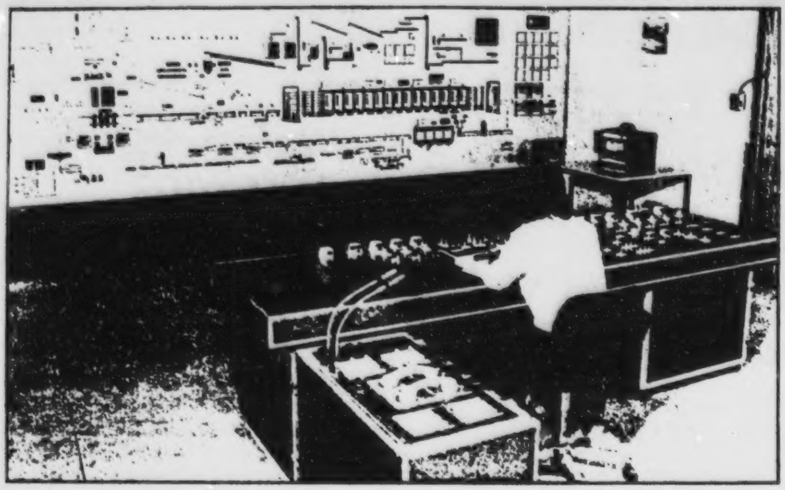
Eastern Europe and Third World countries have been leaders in the application of gypsum fiberboard technology. Why is this so? One reason is that planned-economy nations generally have an active public housing program where this product fits readily into mass production of building elements. Another is the readily available raw materials, i.e., gypsum and waste paper. Gypsum $(CaSO_4.2\,H_2O)$ is a common mineral with working or workable deposits throughout the world and is also available as the byproduct of flue gas desulfurization. Plants similar to the Fels-Werke described in the accompanying article have been installed by Siempelkamp in Egypt, India, Iran, and Israel as well as in Bulgaria, USSR, and Yugoslavia. The board sizes average around 4' x 10' (off the press). In four cases, plants for calcination of gypsum have been installed along with the panel production lines.

The plant has been automated to the fullest possible extent. The process part and the board production line are controlled and monitored by PC installed by Germany's Klöckner-Moeller. A graphic panel for the main production line provides the operators with a birdseye view of the process.

Although the materials are different, GFB manufacture bears much resemblance



The Fels-Werke gypsum fiberboard mill is located at the town of Seesen in Lower Saxony, Germany, not far from Hannover.



The GFB production process at Fels-Werke features a high degree of automation, with PC from Klöckner-Moeller of Germany.

The cellulose component of GFB is waste paper fiber, cheap and plentiful and offering fibers which combine well with mineral material.

to particleboard or MDF in plant layout and the general nature of the hardware involved. The raw material side is much simpler than that for the other types of boards with the fiber or chip drying phase not required for GFB.

Cellulosic portion

Although it is possible to use wood fiber obtained in such processes as cooking and refining of chips (as in MDF manufacture), waste paper was selected as the best wood-based cellulosic raw material. It is plentiful and cheap in the Northern Germany collection area. Furthermore, the paper fibers have properties which combine excellently with the mineral in the furnish. Although the paper comes in relatively clean, up to 0.5% contaminants are permitted and cause no harm.

Fiber makes up 17%-18% per cent of the total furnish. It is received in the form of both over-issue and post-consumer newspapers and magazines, about 60:40 newspapers/magazines. It is trucked into the plant's covered storage. The paper is loose — no bales. Handling is by a grapple hung from an overhead bridge crane. The paper is fed onto an inclined conveyor and passed through a metal detector, which stops the conveyor in case any sizable tramp iron is present. It is then sent via a hammermill to three bunkers, from which it is dosed out for the final preparation steps. These consist of magnetic staple removal, fiberizing, and screening.

The fiber is then blown to a dosing bunker and fed onto the belt scale. The weight of the fiber then determines the amount of gypsum going into the furnish.

Mineral part of furnish

The plant is in an ideal location for obtaining mineral raw material from a private gypsum plant only 10 miles away. The plaster of paris product (for simplicity hereinafter referred to as gypsum) comes in by silo trucks and is stored in four silos. It is fed from the silos into a blender where it is joined with recycled material from the process and with sander dust from the board line. (The recycling wherever possible is a feature of the process.) The blended material goes by mechanical transport to a silo and is dosed by screw to a belt scale. Just over 80% is gypsum.

Gypsum and fiber are blended in a paddle-type unit and the mixture is then screw-conveyed to the bunker ahead of the matformer.

Mechanical matforming

The mix is deposited by the matformer onto a synthetic porous drainage belt. Excess material is skimmed off to make a uniform mass. Discs trim off the edges, and this material is mechanically returned to the matformer bunker. Mats are rejected if not within thickness tolerance.

After the pre-compressing stage, water is flowed onto the mat. It penetrates the board, which is at that point supported by vacuum boxes underneath. The pre-press reduces a 40 mm-thick mat, e.g., to 27 mm. It is now ready for the main press.

Main pressing step

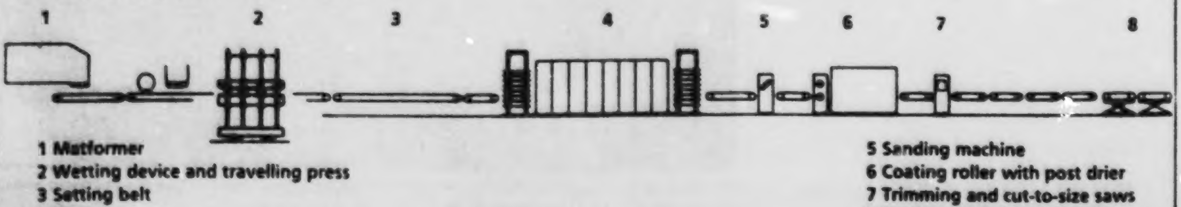
The main press has a single opening and is a travelling unit which produces an endless ribbon of gypsum fiberboard. It is a downstroke type with a maximum pressure of 700 psi and features eight hydraulic cylinders. An upper belt goes through the press. The board is carried into the press on a screen draining belt which imparts a screen pattern on the back. The movement of the press is synchronized with the belt speed. Water removed is cycled to a decanting pit and clear water recovered and pumped to a reservoir. Thus no water is wasted during the process.

There is a small springback in the board as it emerges from pressing. Line speed of the press is 12 m/min.

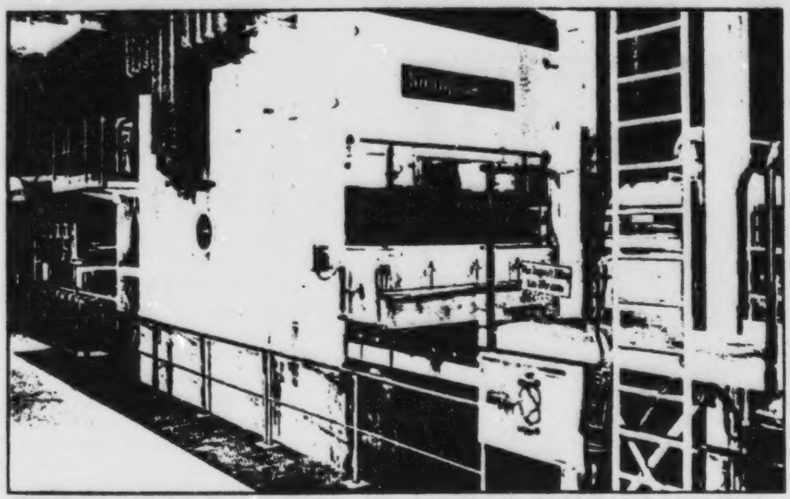
The pressed, wet, endless board is delivered onto a "setting" belt where the gypsum sets. The edges are cleanly trimmed by a water jet just before the setting belt.

A flying crosscut saw produces boards of desired length (max. 20 ft) but usually

Production of gypsum fiberboards



1 Matformer
2 Wetting device and travelling press
3 Setting belt
4 Drier
5 Sanding machine
6 Coating roller with post drier
7 Trimming and cut-to-size saws
8 Stacking of finished boards



The single-opening hydraulic press movement is synchronized with the belt speed. Water removed is recycled. Siempelkamp was main press and plant turnkey supplier.

double the panel length needed. Accelerating belts take over to move the boards into the elevator ahead of the dryer.

According to Egon F Kraemer, Siempelkamp authority, the drying of GFB is a highly sensitive process; much careful engineering was required to obtain the proper balance in H_2O removal. The eight openings of the elevator feed the boards into the eight decks of the dryer at the rate of speed one-eighth that of the dryer line speed. Boards are carried through the dryer by long-life metal screen conveyors. The dryer is equipped with 15 drying zones. The first section of the dryer is unheated thus acting as a further setting zone. Subsequent zones are heated by natural gass and controlled individually to avoid over-drying. Temperatures range from 400°-200°F, with lowest temperatures at the end. The drying is by jets top and bottom, said to be more uniform than if placed at the side.

Initial moisture content is 25%-28%, with final m.c. at 0.8%. Excess water is evaporated and exhausted by fans to the atmosphere. Heat recovery is possible but such a system has not yet been installed.

There are two principal finishing departments; however, after drying all boards are carried automatically into the sander for top-surface smoothing and calibrating, only rarely is the screen underside sanded. After sanding, each board receives a coating of silicon emulsion to control the dust; the treatment also repels water and acts as a release agent for wallpaper application. A dryer is used to evaporate the water of the silicon emulsion.

The full-size boards (8' × 20') and the other boards which are not to be reduced in size are conveyed straight ahead for withdrawal onto pallets. Boards to be cut smaller receive an edge trim and then a center or off-center cut to the desired (usually standard) size.

Ten of the popular "one-man board" size measuring 1.0 × 1.5 m can be cut from the 2.5 × 6-m panels and then move on to the auto stacking and palletizing. Except for the very large panels, the boards are then covered with shrink wrap and put through a heat station.

The new cut-to-size department is computerized and features PLC. Costing about $3 million, it was installed to handle 250 different special sizes for Fermacell boards. This is an immense setup and is fully automated. It consists of cutting to size, stacking, and storing panels of 1.5' × 1.5' up to 4' × 13' (nominal). The boards are stacked up to 5' high, or a max stack weight of 4,000 kgs. The stacks pass through an automated strapping line.

The stacks are automatically transferred to the warehouse and stored according to each client's special order. There are four stacking bays per vertical section, with computer-dictated placement of stacks.

The whole process of cutting to size, handling, stacking, storage, retrieval, etc is overseen by a single operator.

Board properties and uses

The main thicknesses (nominal) are 3/8", 1/2", 5/8", and 3/4". Density is 75 lbs/ft^3. Due to the low fiber content, Fermacell has an official classification as an incombustible building material. The cost is 15%-20% over conventional gypsum wallboard and about 15% below fireproof impregnated wallboard.

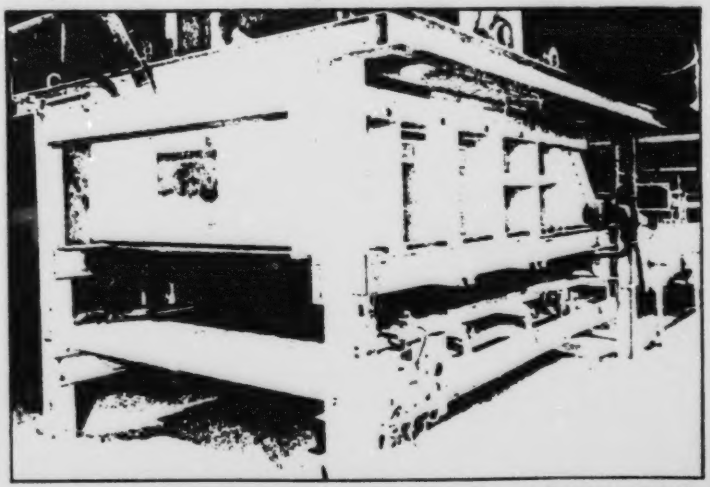
There are four main use sectors:

- Walls and partitions.
- Ceiling construction.
- Composite boards for insulation (sandwiched with polystyrene).
- Flooring elements.

The earlier-mentioned one-man boards are extremely popular in the DIY market. The 3' × 5' size (actually 1.0 × 1.5 m) fits the modular dimensions of Europe. It is easy to

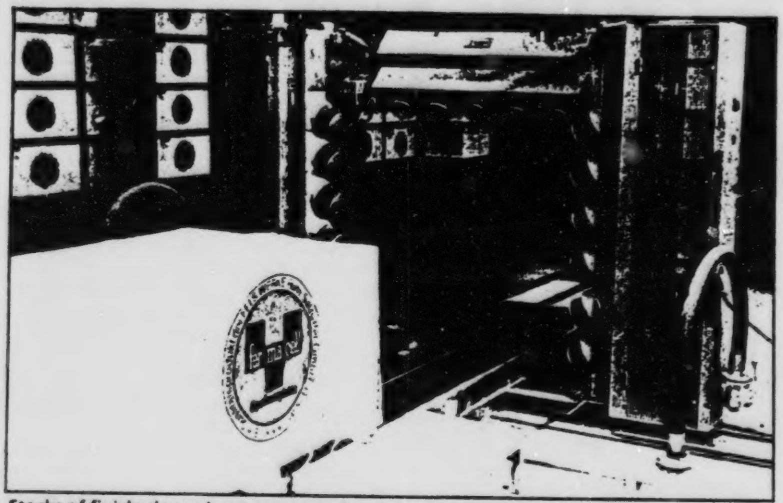
Key suppliers to Fels-Werke gypsum fiberboard plant

		Reader Svc No
Turnkey contractors and suppliers of major production equipment (former, pre-press, press, dryer, and related conveying equipment)	Siempelkamp, Krefeld	**270**
Hammermill	Lindemann	**271**
Fiberizers	Condux	**272**
Blender	Drais	**273**
Sander	Steinemann	**274**
Finishing and handling	Siempelkamp, Starnberg	**275**
Standard sawing installation	Schwabedissen	**276**
Cut-to-size sawing installation	Anthon	**277**
Packaging (strapping)	Signode	**278**
Chemical processes	Fels-Werke	**279**
PC	Klöckner-Moeller	**280**



The mixture of cellulose fiber and gypsum is put through a mat-forming unit and deposited on a transport belt.

Mill Operations



Stacks of finished panels are compacted and shrink-wrapped for shipment to both German domestic and export markets.

handle, and the household can, with a minimum of time and expertise, easily finish off an attic or re-do a room in an old building. Fermacell officials told WBPI that their product can be used in a lesser thickness than wallboard for similar applications.

Prefab housing builders are a major consumer of Fermacell. By using cut-to-size boards, such firms can develop cost-effective working methods. Fermacell 8' × 20', claimed as "the world's biggest gypsum panel," is used in prefab construction with great savings in handling and application.

The sandwich panel (gypsum fiberboard and polystyrene) finds wide use in improving the insulation of brick walls in old buildings. Some of these panels utilize an aluminum-foil vapor barrier of 50 microns. Other insulating materials besides the polystyrene are used, according to national convention.

Floor elements of GFB is an area which has seen strong growth, due to quick installation time, no drying time needed, and good sound insulation along with low weight. The Fermacell Floor Element consists of two 3/8" boards glued together. The ¾" laminated board can then be bonded to an insulation material as needed.

For ceilings, only the 3/8" board is used, and Fermacell has shown this use to be very economical and practical (against fire).

Fermacell has worked out engineering details on the manufacture of elements for innumerable uses.

These can all be seen in their own applications center, located not far from the mill, which is open to clients and building specialists, and officials.

Fels-Werke does very little panel upgrading (in the value-added sense), although they see this as a future possibility.

APPENDIX VII

ILVES MINERAL - TECHNICAL REPORT

METSÄLIITON TEOLLISUUS OY
WOOD-BASED PANEL DIVISION

V. Loiri/RM/pp

Date
July 1986

TECHNICAL REPORT

Ilves Mineral

CEMENT BONDED PARTICLE BOARD

METSÄLIITON TEOLLISUUS OY
WOOD-BASED PANEL DIVISION

ILVES MINERAL - CEMENT BONDED PARTICLE BOARD

1.
GENERAL

In many countries wood has been a traditional, commonly used building material. The beauty, easy machining, good heat and sound insulation are the advantages of wood. The fire regulations have limited the use of wood in many cases, especially in high rise, office and public buildings, in general in rooms where a lot of people may gather. The serious hotel fires in recent years will increase the need to use materials with better fire properties. More consideration will have to be given to furniture materials, floor coverings, carpets and textiles.

The selection of panel products with better fire properties than those of wood is rather small. The best known are gypsum plaster board, asbestos cement boards, chemically treated particle boards and portland cement bonded particle boards.

The health hazard from asbestos is the disadvantage of asbestos cement boards. Plaster boards are mechanically poor and do not tolerate moisture. The fire properties of conventional particle boards can be improved by adding fire retardant chemicals to the panel. However, the chemicals reduce the gluing strength, make panel hygroscopic and the protection effect may diminish in time. Also the formaldehyde of UF-binders has lately caused quite a problem.

Combining wood and cement has been known for a long time, for example for the manufacture of bricks and wood wool lightweight (excelsior) boards. Few years ago boards based on wood chips, cement and additives began to enter the European markets.

2.
ILVES MINERAL (Ilves Brand in Scandinavia)

Ilves Mineral is a new Finnish building board for indoor application developed and manufactured by Metsäliitto. It is the result of many years R & D work and utilizes the properties of special cement, made of hydrolic slag. Wood particles, cement, water and activators are formed into a panel with a density of about 1300 kg/cbm. The dry weight is in the ratio of 30 % wood and 70 % cement. Advantages of Ilves Mineral are:

- very good fire resistance
- good sound insulation, due to relatively high density
- good heat insulation, due to wood particles
- good mechanical strength and impact resistance
- insignificant smoke production in fire
- no asbestos, formaldehyde or other toxic substances
- the cement gives no toxic fumes in fire
- resistant to fungi, termites and rot
- moisture resistance

Ilves Mineral fills the gap between traditional particle board and asbestos cement products.

Ilves Mineral offers wide range of boards:

Ilves Mineral Basic Board:

Basic Board with squared edges or grooved to take loose tongues

Size: 1200 x 2600 mm
Thickness: 8, 10, 12, 15, 18, 22, 25 and 32 mm

Ilves Mineral Wall and Ceiling Panels:

Wood veneered, melamine or wallpaper coated panels. Edges grooved for various fixing methods.

Length: 2600 mm
Width: 190, 290 and 590 mm
Thickness: 12 mm (basic board)
Coating: beech, oak, birch and pine veneer,
white or wood-grain melamine foil,
wallpaper

Other sizes, thicknesses and wood species to order. Wood veneered are normally lacquered and also stained if required.

Decorative Finished Std Panels:

Possible finishes are e.g. alkyd primer, paint, various foils, films and laminates.

Size: 1200 x 2600 mm
1190 x 2590 mm
Thickness: 12 and 18 mm
Std finish: alkyd primer 120 g/m2
melamine foil 145 g/m2
phenol film 117 g/m2
high pressure laminate

Ilves Mineral Acoustic Panels:

Perforated or slotted, normally wood veneered boards with a choice of various edges:

Size: 590 x 590 mm
1190 x 590 mm
Thickness: 12 mm (basic board)
Coating: beech, oak, birch and pine veneer,
melamine foil

Other sizes, thicknesses and wood species to order. Wood veneered are normally lacquered and also stained if required.

Ilves Mineral Dry Wall System:

The system is based on grooved Ilves Mineral Boards which are secured by the grooves to a specially designed steel frame.

3. HANDLING OF ILVES MINERAL BOARDS

Storaging:

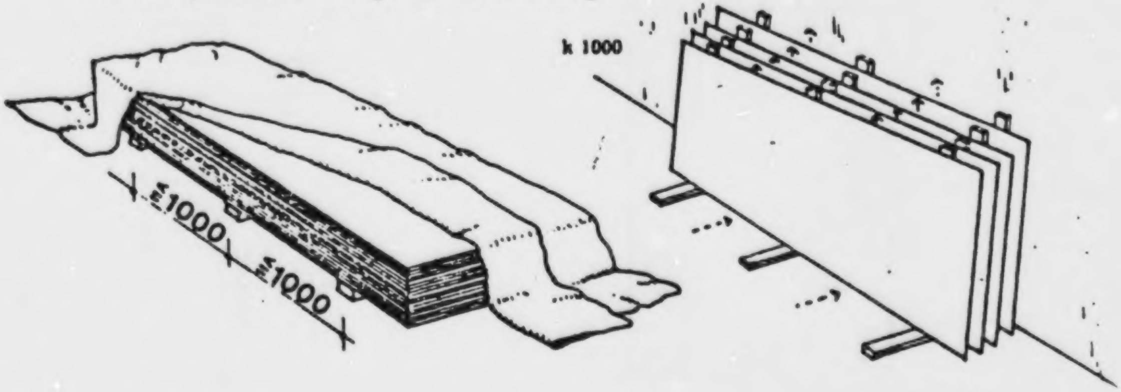
Ilves Mineral Boards should be stored in dry conditions, preferably under cover sheltered from rain and moist air. The boards must not be stored in conditions under which the humidity considerably differs from those of final use.

The boards should be stored horizontally on a level base. Wood supports must be placed quite close to each other (in distances of about 1000 mm, the width of the support about 100 mm) to prevent bending of the boards (3 or 4 supports for standard size panels).

Conditioning:

The moisture content of the board when it leaves the factory is about 8 % ± 3 %, corresponding to the humidity level of warm indoor areas. When the boards are used in cold indoor places or in areas where occasional dampness from construction can occur, they should be conditioned as close to the final conditions as possible.

For the conditioning the boards should be placed edgewise and ribbed. Another way of conditioning is to fix the boards to the wall from the middle of the board. The edges will not be fixed until the stabilization. 3 to 7 days will be enough for conditioning.



Machining:

Normal wood machining methods are suitable for Ilves Mineral boards. The boards should be sawn with a hard metal blade. The blade has the best durability when the number of teeth and the rotating speed are moderate (e.g. 32...40 teeth, Ø 200 mm, 2-3000 r.p.m.). To avoid break-out of the surface a dense-toothed blade should be used for sawing of coated boards.

Holes for wall plugs and switches should be made with a hard metal tipped key hole saw, an adjustable hole cutter or a jig saw. Sawing can create dust, which may be inconvenient for continuous sawing work. To make the work more comfortable the use of a saw equipped with dust removal or the use of a light face mask is recommended.

Suface treatment:

Ilves Mineral boards can be painted, wall-papered, veneered or laminated by using normal working methods developed for wood panels. When choosing the glue and paint the slight alkaline nature and absorbency of the panel surface must be born in mind.

Painting Before painting nail heads and other indentations should be filled. Suitable paints are latex, alkaline 2-component, epoxy and polyurethane-based paints.

In dry areas two coats with normal latex or alkyd paint is enough. In could and/or damp areas acrylic latex paints mixed with alkyd (water-based) or other similar paints should be used.

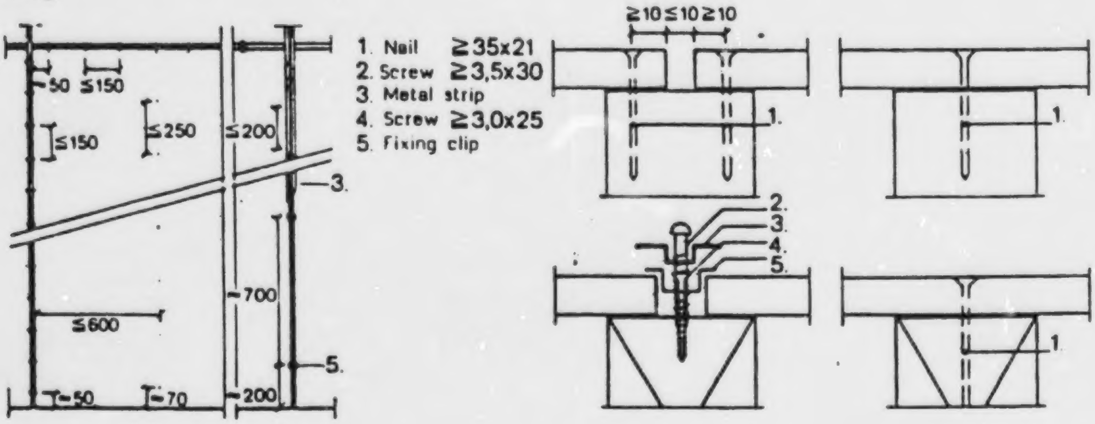
Wallpapering

With normal paste.

4.
INSTALLATION OF BOARDS

Ilves Mineral Basic Boards:

Fixing



Ilves Mineral boards for wall linings can be fixed with nails, screws, glue, cover strips, or special clips. 8 mm and 10 mm boards can be nailed like ordinary chipboard with galvanized twist shank, annular ring shank or chipboard nails. 12 mm boards can be nailed with tempered nails. When fixing boards over 12 mm a hole should be predrilled for the nails.

Distances between nails or screws:	150 mm at the edge 250 mm in the middle
Distance of nails from the edge:	not less than 10 mm

An expansion gap should be provided at all abutments: 3 to 6 mm open joint in dry areas, 6 to 10 mm in cold and/or damp areas.

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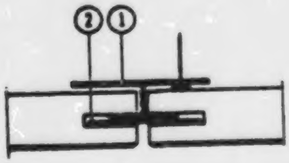
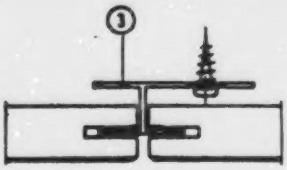
Ilves Mineral Wall and Ceiling Panels:

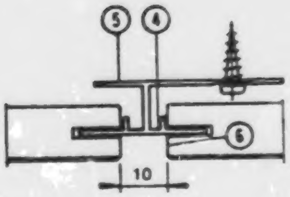
Type of joints



Type 1



Type 2



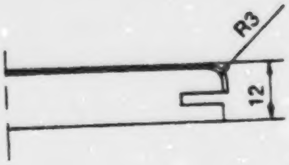
Type 3

1. Fixing clip (cc. 300 mm)
2. Black steelband
3. Aluminium fixing profile PI 3510
4. Decorative cover strip
5. Aluminium fixing profile PI 4510
6. Decorative PVC cover strip

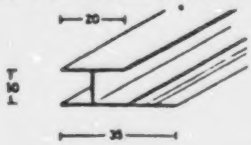
Type 1: Butt joint, invisible installation with fixing clips in the groove together with black steel band. This method is suitable for fixing 190 mm and 290 mm wide panels to the wall. Only for ceilings type 2 or 3 are always recommended.

Type 2: Butt joint, invisible installation with profile PI 3510 in aluminium.

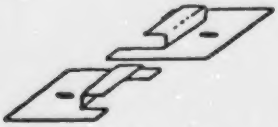
Type 3: Open joint, fixing with profile PI 4510, which can be covered by decorative strip or painted if necessary. The edges of panels are covered with decorative strips.



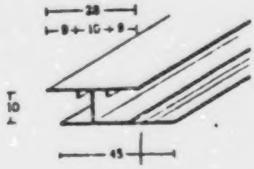
The edge of melamine or wallpaper covered panel



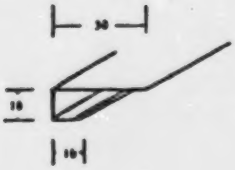
PI 3510



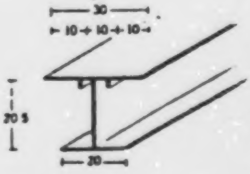
Fixing clips



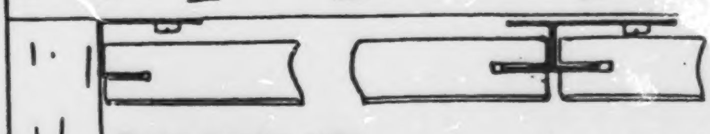
PI 4510



Starting profile



PI 2030

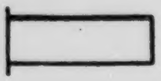


The use of starting profile

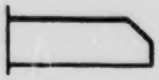
Ilves Mineral Acoustic Panels:

The Acoustic Panels can be installed in the same way as normal panels, e.g. to the wooden batten or by the following methods:

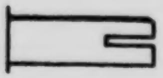
Edge alternatives



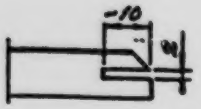
Type 1



Type 2

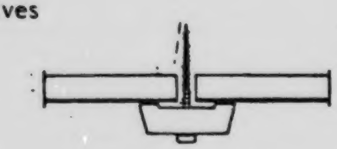


Type 3

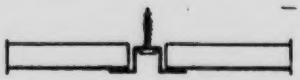


Type 4
(Standard)

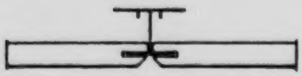
Fixing alternatives



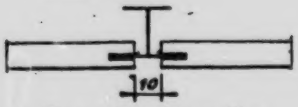
Wooden cover strip



Steel cover strip
or aluminium

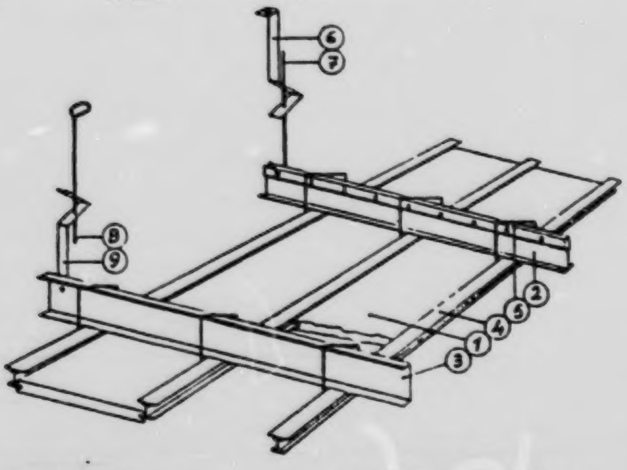


Butt joint with profiles
PI 2030 or PI 3510 to the
supporting system or wooden
patterns



Open joint with profiles
PI 2030 or PI 4510 to the
supporting system or wooden
battens

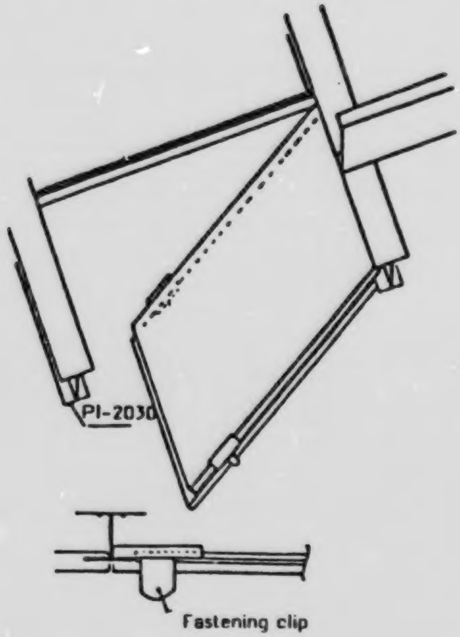
Suspended ceiling



1. Ilves Mineral Panel
2. Primary channel DIL-370
3. Primary channel DCU-38-88
4. Profile PI 2030
5. Wire clip
6. Hanger spring K
7. Wire hanger N
8. Wire hanger M
9. Hanger spring L

Inspection Panel for suspended ceilings

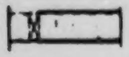
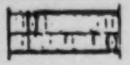
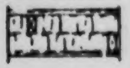
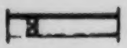
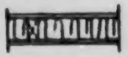
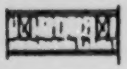
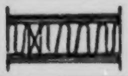
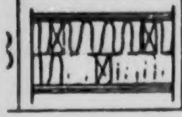
Size: 590 x 590 mm or 1190 x 590 mm.



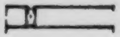
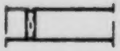
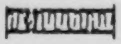
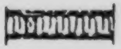
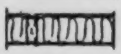
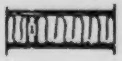
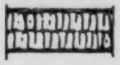
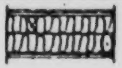
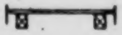
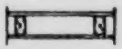
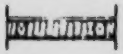
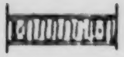
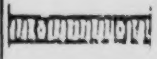
5.
ILVES MINERAL CONSTRUCTIONS, FIRE RESISTANCE, SOUND INSULATION

(to be cont. on next page)

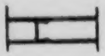
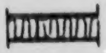
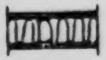
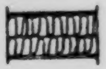
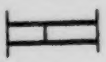
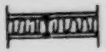
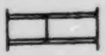
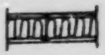
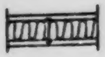
FIRE DIVISION WALL WITH WOODEN FRAME, LOADBEARING

	CONSTRUCTION	PANEL mm	FRAME mm	INSU-LATION mm	THICK-NESS mm	WEIGHT kg/m2	MAX. HEIGHT m	FIRE RESIST.	SOUND INS. dB
		10	95	95	115	35	5	B-30	44
		10	70+70	70+70	160	60	5	B-60	52
		10+10	70+70	70+70	180	55	5	B-60	56
		10	min. 45x70	-	90	30	-	B-15	32
		12	min. 45x95	120 mm rock wool	119	35	-	B-60	44
		10	min. 45x95 and 45x45	95+45 mineral wool	160	60	-	B-30	45
7		12+13	min. 45x120	120 mm rock wool	174	65	-	B-60	48
		12+12	45x120 and 45x120	120+120 mineral wool	288	65	-	B-60	56

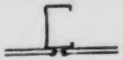
FIRE DIVISION WALL WITH WOODEN FRAME, NON LOADBEARING

	CONSTRUCTION	PANEL mm	FRAME mm	INSU-LATION mm	THICK-NESS mm	WEIGHT kg/m2	MAX. HEIGHT m	FIRE RESIST.	SOUND INS. dB
1		10	70	-	90	36	4	B-15	32
2		10	95	-	115	30	4	B-15	35
3		10	70	70 mm mineral wool	90	35	5	B-30	40
4		10+10 chipboard	70	-"-	110	50	5	B-30	45
5		10	95	95 mm rock wool	115	35	5	B-60	44
6		10+10 chipboard	95	95 mm rock wool	135	50	5	B-60	48
7		10	70+70	70+70 rock wool	160	60	5	B-90	52
8		10+10 chipboard	70+70	70+70 rock wool	180	55	5	B-90	56
9		12	min. 45x45	-	37	18	-	B-15	30
10		12	min. 45x70	-	94	35	-	B-30	35
11		10	min. 45x70	70 mm rock wool	90	35	-	B-30	40
12		10	min. 45x95	95 mm mineral wool	115	35	-	B-30	44
13		12+12 or 25	min. 2x45x70	-	96	35	-	B-30	35
14		10	min. 45x95	95 mm rock wool	115	35	-	B-60	44

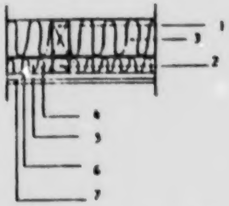
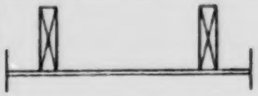
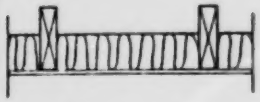
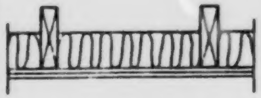
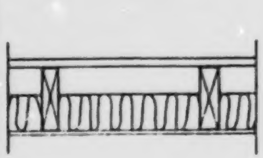
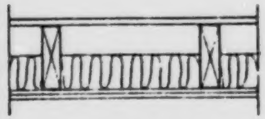
FIRE DIVISION WALL WITH STEEL FRAME, NON LOADBEARING.

	CONSTRUCTION	PANEL mm	FRAME mm	INSU-LATION mm	FIRE RESIST.	SOUND INS. dB.
1		8, 10, 12	70	-	B-15	-
2		8, 10, 12	70	70	B-30	-
3		8-8	95	95	B-60	-
4		8, 10, 12	70+70	70+70	B-60	-
5		12	70 (wall 94 mm)	-	B-15	35
6		12	70	70 mm rock wool	B-60	44
7		12	95 (wall 120 mm)	-	B-15	35
8		12	95	95 mm rock wool	B-60	44
9		18	95 (wall 130 mm	95 mm rock wool)	B-60	48

THE FIXING OF PANELS IN WALL NUMBERS 1-4:


steel cover strip

WOOD FRAMED CEILINGS

	CONSTRUCTION	FIRE RESIST.	
1		B-30	1. Wooden joist 2. Batten 45 x 45 3. Mineral wool 100 mm 4. Mineral wool 30 mm 5. Hard board 3,2 mm 6. Open boarding, gaps 250 mm, or steel wires, cc = 300 mm or wire net 7. Ilves Mineral 8 mm
2		B-15	Ceiling fixed to wooden joists (bearing beam min. 45x170 mm, cc ≤ 1200 mm) on under side min. 13 mm building panel.
3		B-15	Ceiling fixed to wooden joists (bearing beam min. 45x170 mm, cc ≤ 1200 mm) on under side min. 9 mm building panel. Between beams min. 95 mm mineral wool.
4		B-30	Ceiling fixed to wooden joists (bearing beam min. 45x170 mm, cc ≤ 1200 mm) on under side min. 24 mm (2x12 mm) building panel. Between beams min. 95 mm mineral wool.
5		B-30	Ceiling fixed to wooden floor joists (bearing beam min. 45x170 mm, cc ≤ 600 mm) on upper side min. 22 mm grooved building panel and on under side min. 9mm panel. Between beams min. 95 mm rock wool.
6		B-60	Ceiling fixed to wooden floor joists (bearing beam min. 45x170 mm, cc ≤ 600 mm) on upper side min. 22 mm grooved building panel and on under side min. 24 mm (2x12 mm)panel. Between beams min. 95 mm rock wool.

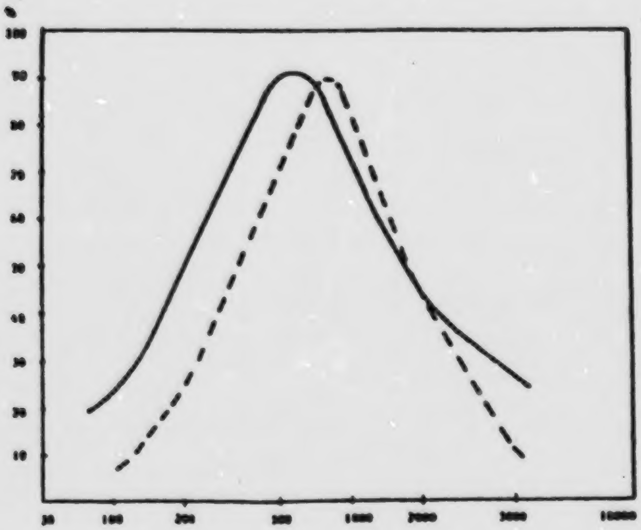
In Constructions where mineral wool is used, it must be secured by steel wire(cc = 300 mm), wire net or open boarding (19 mm, gap max. 200 mm).

6.
ACOUSTICS

The purpose of Acoustic Panels is to absorb noise in appropriate rooms.

The sound absorption varies according to the gap between the front and back panels and also if mineral wool is used.

Absorption Diagram:

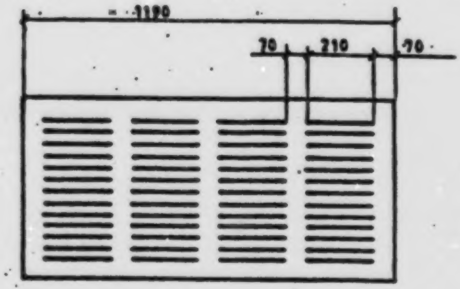


50 mm space filled with mineral wool behind the panel.

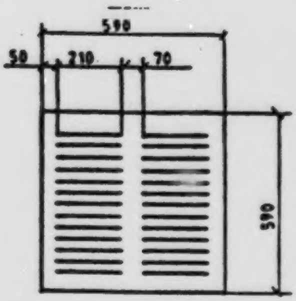
Perforation alternatives of Acoustic Panels:

Slotted

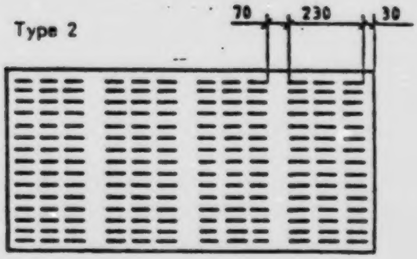
Type 1



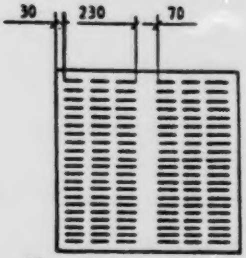
The area
of holes
about 13 %



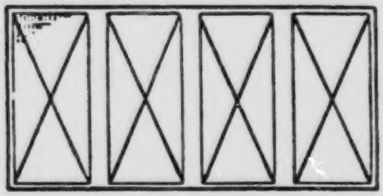
Type 2



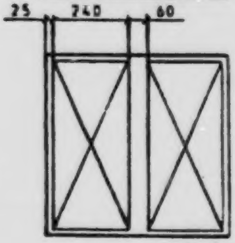
The area
of holes
about 13 %



Perforated

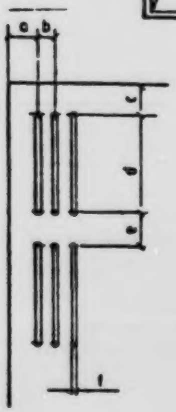


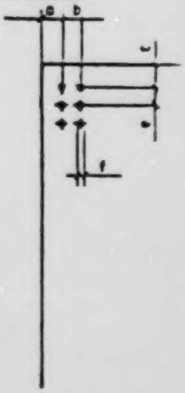
The area
of holes
about 10,5 %



Dimensions

	SLOTTED				PERFO-RATED	
	TYPE 1		TYPE 2			
	119x59	59x59	119x59	59x59	119x59	59x59
a	67,5	67,5	32,5	32,5	25	25
b	35	35	35	35	20	20
c	70	50	30	30	25	25
d	210	210	60	60	-	-
e	70	70	25	25	20	20
f	8	8	8	8	8	8





METSÄLIITON TEOLLISUUS OY
WOOD-BASED PANEL DIVISION

INSTRUCTION

July, 1986

ILVES MINERAL FLOORING PANELS

Size:	1200 x 2600 mm
Thicknesses:	18, 22 and 25 mm
Edge alternatives:	1) Square edged 2) Grooved edges with a loose plywood tongue

Recommendation for supporting distances on joists:

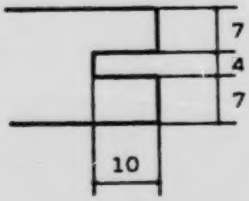
18 mm	only for floating floors (in accordance with the Technical Manual of Chipboard Promotion Association (CPA))
22 mm	400 mm for normal loads 300 mm for heavy loads
25 mm	500 mm or 400 mm

Recommendation for nail or screw distances:

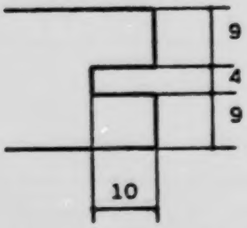
20 cm at the edge of board (square edge 10 cm)
40 cm in the middle of board (square edge 20 cm)
Distance of the nail row from the edge of the board not less than 15 mm

Dimensions of grooved edge:

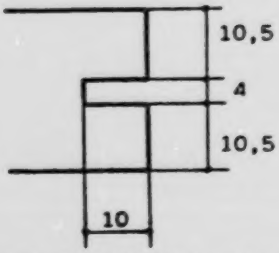
18 mm



22 mm



25 mm



Fixing of the strip: The loose plywood tongue 4 x 18 mm to be fixed with PVAc-glue

Other instructions: According to the Technical Manual of Chipboard Promotion Association

METSÄLIITON TEOLLISUUS OY
WOOD-BASED PANEL DIVISION

July, 1986

PANEL PRODUCTS PROPERTY COMPARISON

	Iives Mineral	Chipboard	Asbest-cement-cellulose board	Gypsum Panels
DENSITY kg/m3	1200...1400	700...750	1450	820
BENDING STRENGTH II N/mm2	10...14	15...25	20	7,0...7,5
I N/mm2	10...14	15...25	14	5,0...5,5
ELASTICITY MODULUS N/mm2	4000...5000	2500...3500	8000	low
TENSILE STRENGTH perpendicular to the surface N/mm2	0,3...0,6	0,4...0,8		
THICKNESS SWELLING IN WATER (2 h) %	1...3	2...12		will be damaged
LENGTH EXPANSION BY HUMIDITY RH 35...90 % %	0,15...0,25	0,2...0,3	0,22	0,04
SCREW RETRACTION RESISTANCE N/mm	95	60...100	-	-
SOUND REDUCTION	good	average	good	good
THERMAL CONDUCTIVITY W(K.m)	0,25...0,35	0,10...0,12	0,58	0,15...0,20
VAPOUR TRANSMISSION g/(m.s.Pa)	DIN:4,8 x 10^{-9}	DIN:2,2 x 10^{-9} SLY:3..7x10^{-9}	DIN:3 x 10^{-9}	
RESISTANCE TO FUNGI AND TERMITES	resistant	not resistant	resistant	resistant
pH VALUE	alkaline 9...11	mildly sour	alkaline	-
WEATHER RESISTANCE	resistant coated	not resistant	generally not	not resistant
MOISTURE RESISTANCE	comparable to moisture resistant wood chipboard type III (BS5669:1979) and V-100 (DIN68763)	V-313 yes	yes	generally not
x) WALL FIXINGS	easy	easy	average	difficult
x) FIXING BY NAIL OR SCREW TO THE WALL	good	good	average	bad
x) FIXING BY SPECIAL FITTINGS	-	-	good	average
x) BREAKAGE AND IMPACT RESISTANCE	fairly good	good	average	bad
x) NAILABILITY	fairly good	good	average	average
x) MACHINING	average	good	average	average
x) POSSIBILITIES OF REUSING	fairly good	fairly good	average	bad

x) Base on independent market survey

METSÄLIITON TEOLLISUUS OY
WOOD-BASED PANEL DIVISION

July, 1986

FIRE CLASSIFICATION OF ILVES MINERAL IN VARIOUS COUNTRIES

Finland

Nordtest method NT FIRE 002, Ignitability
- Class 1, Ilves Mineral does not ignite

Nordtest method NT FIRE 004, Tendency to fire spread and smoke development
- Class I, panel does not spread fire
- Smoke density is very low, less than 2 %

The same results are obtained when Ilves Mineral is faced with untreated wood veneer or laminate.

Sweden

In addition to the above:

Nordtest method NT FIRE 003
- tändskyddande beklädnad med flamsäkert ytskikt klass I

Norway

Statens Branninspeksjon, godkjenning nr 157-003
- tennvernende kledning A 10

Denmark

Byggestyrelsen, godkjännandet nr MK 6.31/0273
- klasse A materiale
- klasse 1 bekædning

Iceland

Brunamalastofnun Risikins vidurkenning 1983.7
- Plötuklaedning I Flokki 1
- Byggingarefni I Flokki A

UK

- Class 0 fire propagation (BS 476: part 6, 1968)
- Class 1 surface spread of flame (BS 476: part 7, 1971)

Germany

FMPA Prüfbescheid PA-III 2.1516
- Klasse B1, Schwerentflammbare Baustoffe

France

CSTB No. 80.16502
- Class M_1 (non flammable)

Netherlands

According to NEN 3883 standard and TNO test report No. B-80-674 Ilves Mineral could be classified as follows:
- Inflammability: not easily ignitable
- Contribution to fire propagation:
    - Class 1, surface of very low contribution
    - Class 2 with untreated teak veneer
- Smoke development during fire: low smoke production

The fire resisting time of the board according to Nordtest method NT FIRE 003 in various thicknesses:

8 mm	11 min
10 mm	16 min
18 mm	25 min
25 mm	over 30 min

TAMPEREEN ALUETYÖTERVEYSLAITOS
TAMMERFORS REGIONINSTITUT FÖR ARBETSHYGIEN
P. Piispanen/tp/1199 k

STATEMENT 1 (1)

29.4.1986

Metsäliiton Teollisuus Oy
Hämeen tehtaat

13210 HÄMEENLINNA

Veijo Loiri

SAFETY INSTRUCTIONS FOR ILVES FIREBOARD

Ilves fireboard, produced by Metsäliiton Teollisuus Oy, is about 30 % coniferous wood chips and 70 % slag from a blast furnace, the latter being primarily made up of calcium, magnesium and aluminium silicates. Gaseous substances (for example, formaldehyde) do not evaporate from the board and, when once fastened to the wall, it does not produce dust in an amount that would be considered a health hazard.

During the handling and cutting of the board, however, the dust formed is alkaline. When alkalines come in contact with water (sweat), they can irritate the skin and respiratory organs. Because of this irritating effect and because the dust contains wood particles, we recommend a comparative value of 5 mg/m^3, which is the current occupational exposure limit for wood dust in Finland (1).

If the handling and cutting of the board creates dust levels above the recommended limit, workers should protect themselves by using protective gloves, dust-tight goggles, and a respirator.

1) National Board of Labour Protection. Työpaikan ilman epäpuhtaudet (Impurities in the air of workplaces). Tampere 1981. (Työsuojeluhallituksen turvallisuustiedote 3/1981).

TAMPERE REGIONAL INSTITUTE OF OCCUPATIONAL HEALTH

Reino Laitinen
Director

Päivi Piispanen
M.Sc. (Chem.)

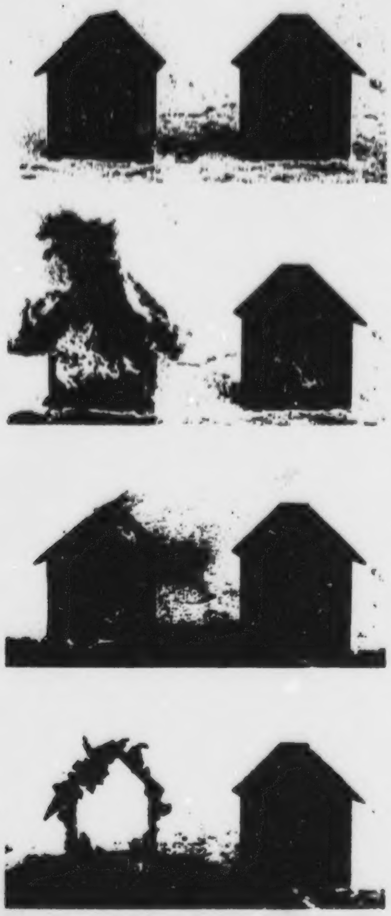
APPENDIX VIII

ILVES MINERAL - PROMOTIONAL MATERIAL

The Versatile Board for Precise Building Requirements.

Ilves Mineral.

Ilves Mineral Combi
# of Wood and

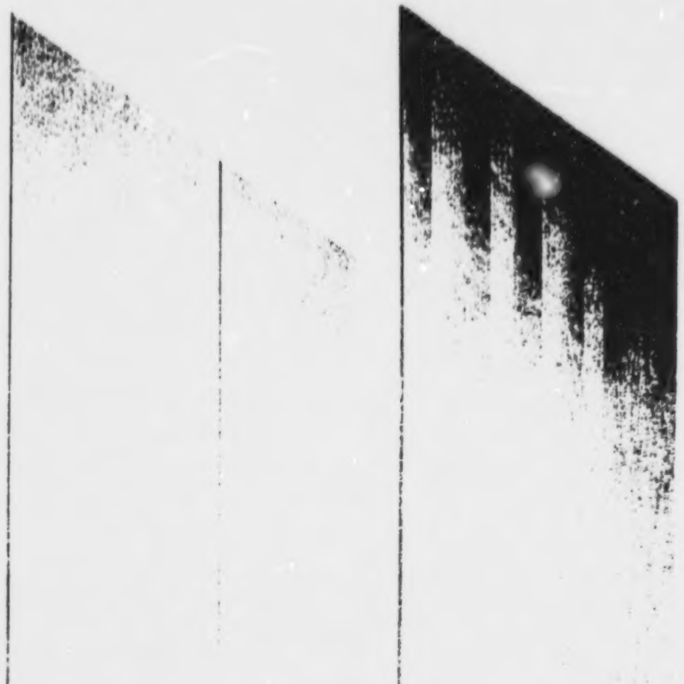


Standard chipboard and Ilves Mineral in a combustibility test.

Standard chipboard Ilves Mineral

Ilves Mineral is a versatile board for demanding building applications. It can be used as a basic structural panel or in a variety of attractive decorative finishes.

The basic raw materials in Ilves Mineral are wood and special type cement. This in effect combines the finest properties of both. Even when coated or faced Ilves Mineral is resistant to the spread of fire. The mechanical strength and impact resistance of Ilves Mineral are very good. In addition, Ilves Mineral has excellent sound insulating properties. It withstands moisture, so making it ideal for humid conditions. It is also suitable for use outdoors when correctly sealed.

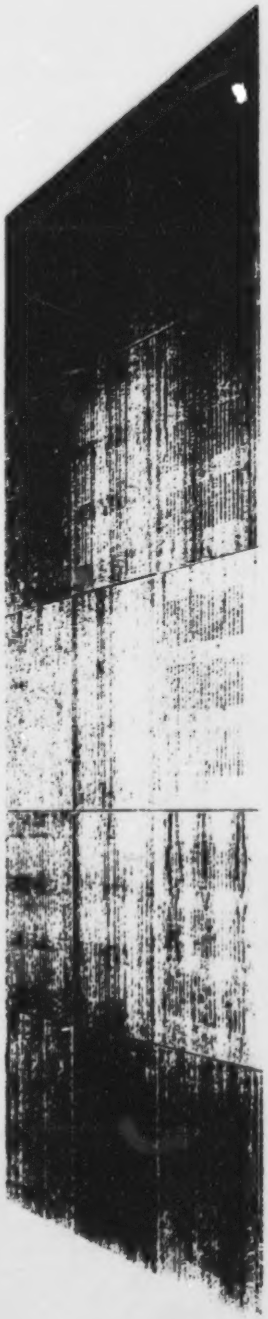


Ilves Mineral basic board

Veneered Ilves Mineral board

nes the Finest Properties Cement.

With the range of boards Ilves Mineral has many uses such as walls, ceilings and floors either square edged or grooved to take loose tongues. The board has a wide variety of finishes. In addition, it is available as acoustic panels and partition wall systems. Therefore Ilves Mineral offers the right choice for every demanding building application.



Ilves Mineral acoustic panel

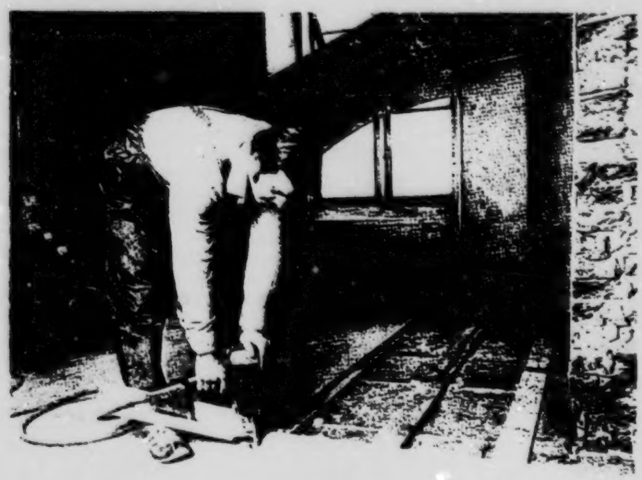
Ilves dry wall system

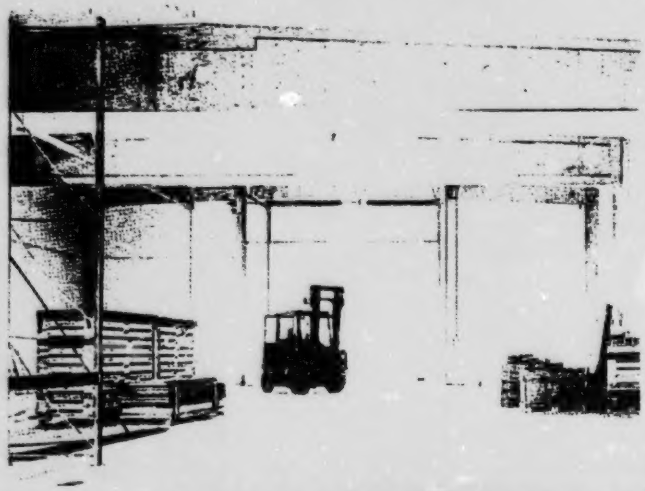
Ilves Mineral from Floor to Ceiling

The wall, ceiling and floor panels of the Ilves Mineral range are basic building boards with a wide variety of end-uses.

Ilves Mineral is equally suitable for new buildings and for renovations. Where strict requirements for fire safety, strength or sound insulation are called for, Ilves Mineral is the right choice. When the fire resistance of ordinary chipboard, or the damp proofing or strength qualities of plasterboard, are not good enough again Ilves Mineral is ideal.

Ilves Mineral as a basic board is an extremely versatile board. It is designed for use in industrial, warehouse buildings, schools, nurseries, offices, boiler rooms and farm buildings. For any of these objects Ilves Mineral has a place from floor to ceiling. No other panel gives the same properties at an equally economical price.





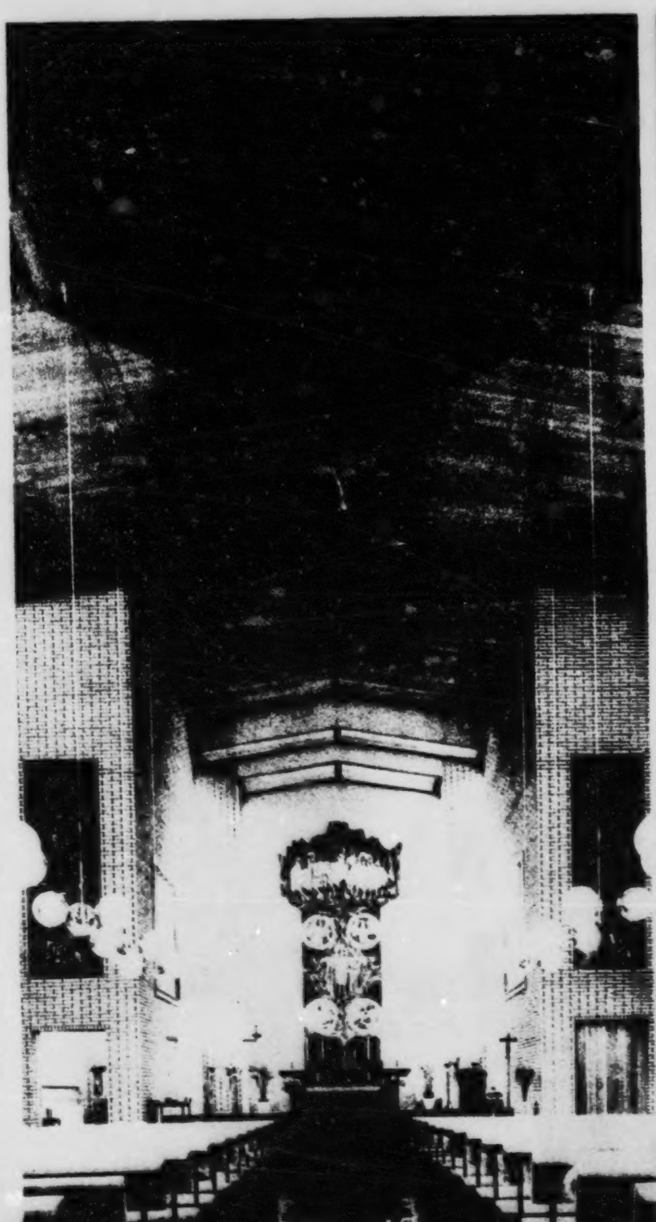
Ilves Mineral
Decorative Panels for Elegance.

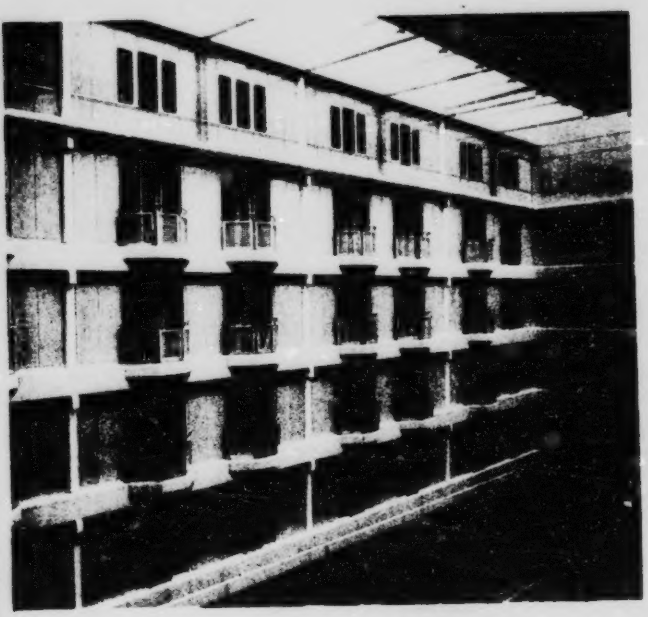
Ilves Mineral decorative panels make attractive interiors in public buildings.

Ilves Mineral prefinished boards have been designed for places where both fire safety and decor standards must be high.

Ilves Mineral allows the use of real wood in public buildings, because when faced with veneers it does not affect the fire safety properties of the board. With Ilves Mineral good sound reproduction can be assured.

The places where Ilves Mineral prefinished boards can be used extend from public meeting rooms and concert halls to hotels, and from sports halls to offices. The many alternative finishes give the specifier of Ilves Mineral a very wide scope. The choice ranges from real wood veneers in oak, beech, birch or pine (or exotic woods to order) to melamine or paint depending on the ultimate effect required.



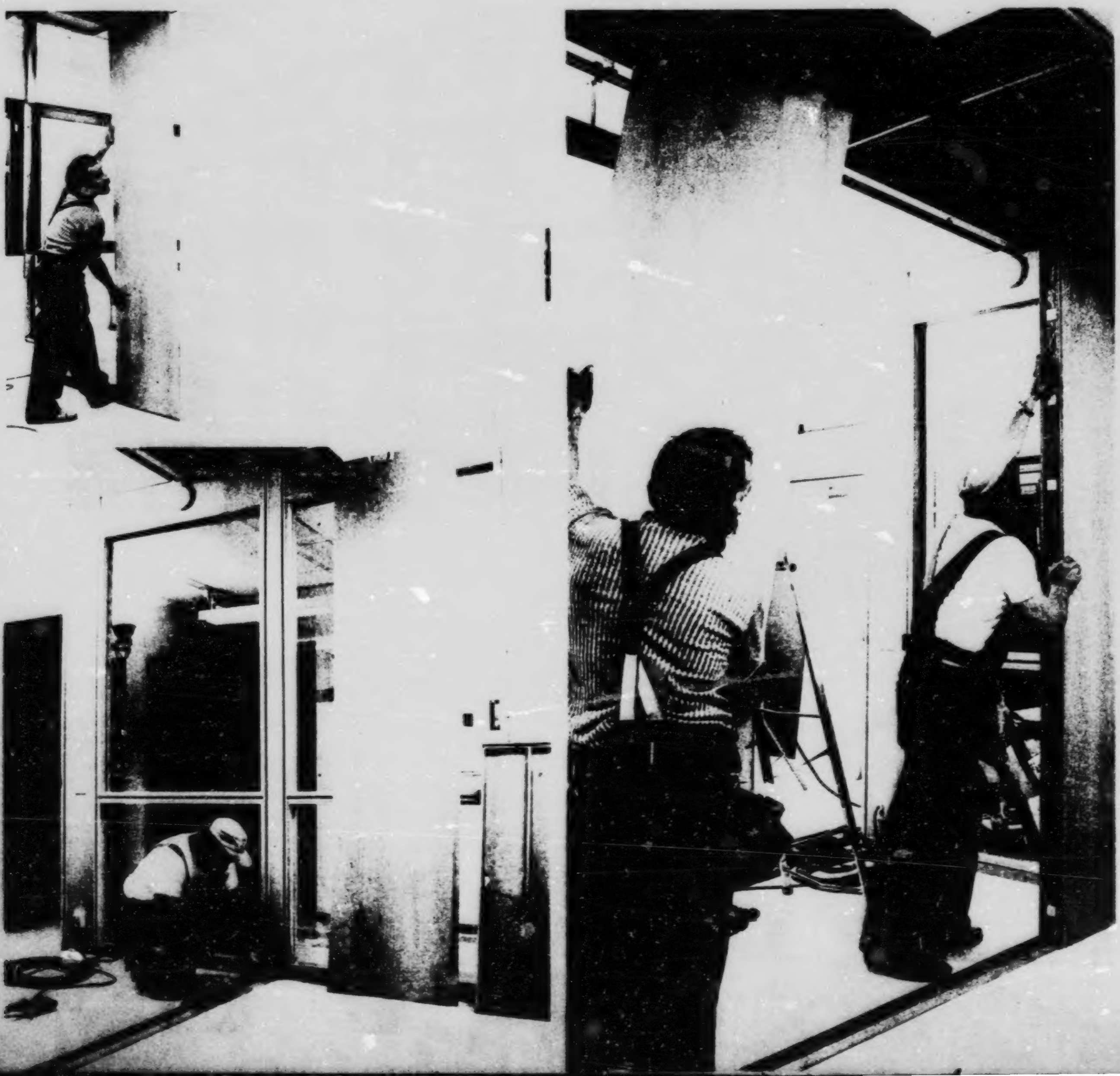


Ilves
Dry Wall System Designed for Fire Safety

Ilves dry wall system is ideal for offices and other public buildings.

The system is based on grooved Ilves Mineral boards which are secured by the grooves to a specially designed steel frame and it is extremely simple to install. The structure also offers better sound insulation and fire resistance than the traditional dry wall systems.

The large choice of finishes ensures that the Ilves dry wall system blends with other interior materials. Combined with Ilves Mineral prefinished boards Ilves dry wall system creates a harmonious and well-integrated interior.

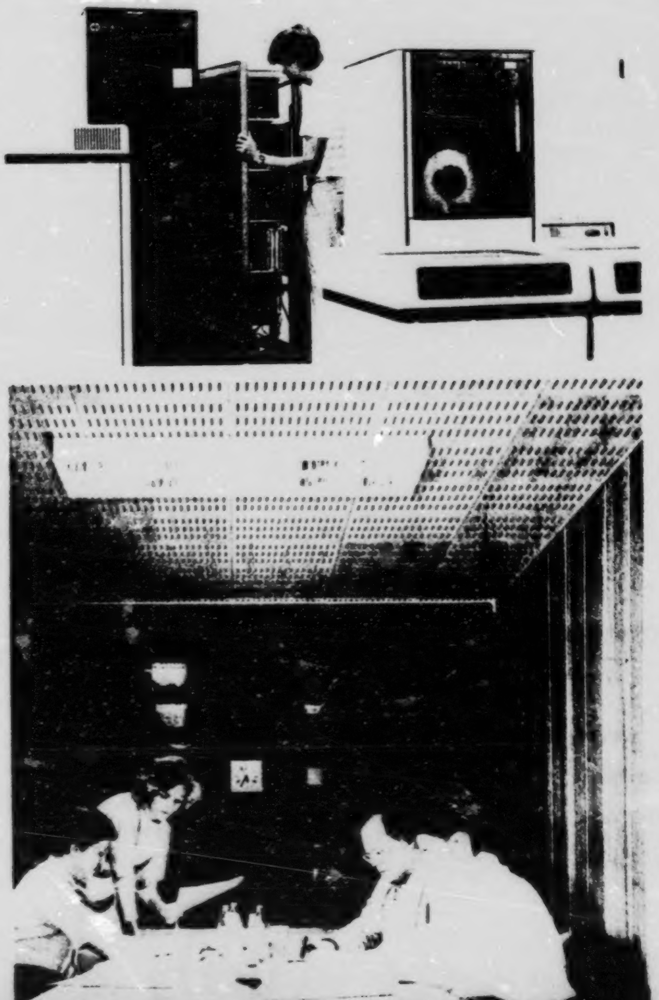


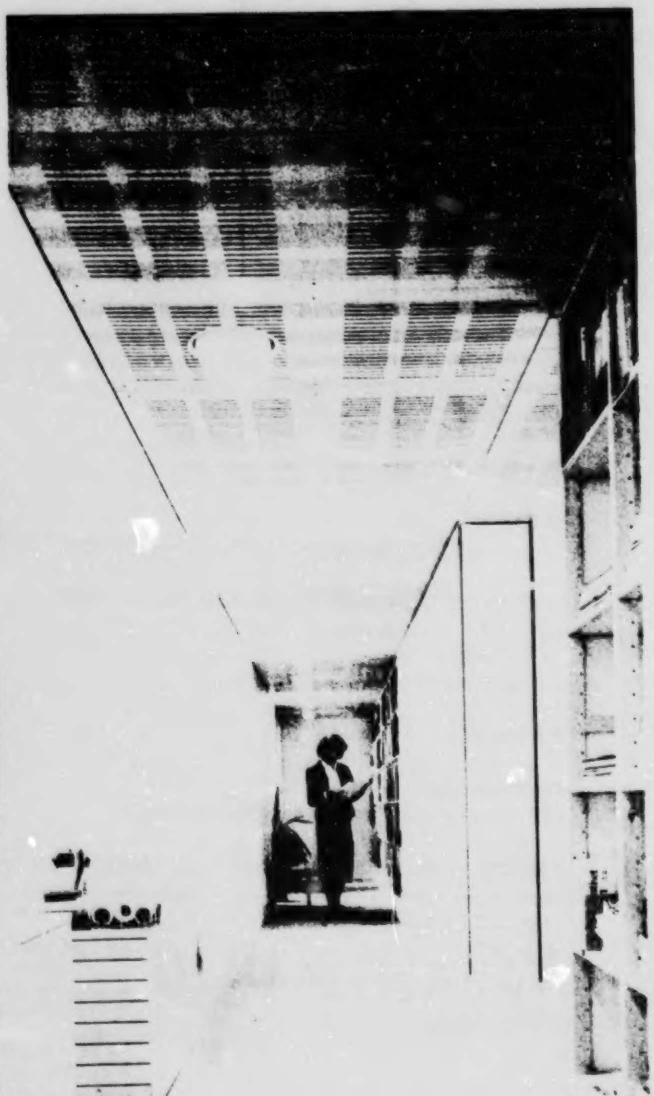
Ilves Mineral Acoustic Panels Give Perfect Sound Reproduction.

Ilves Mineral acoustic panels make attractive interior finishes and can be used for anything from public buildings to offices.

Ilves Mineral acoustic panels are ideal to line walls and ceilings. False ceilings are easily constructed with Ilves Mineral acoustic boards. Perfect sound reproduction in concert halls and auditoriums is ensured. Correspondingly, when used in offices, disturbing noises from corridors can be eliminated. The finished interior is also hygienic: Ilves Mineral acoustic panels do not collect dust and are easy to keep clean.

Ilves Mineral acoustic panels are available in as many different finishes as the other Ilves Mineral decorative panels. Various perforation patterns can also be selected.





[illegible]	[illegible] x [illegible] mm	[illegible]	[illegible]	[illegible]
Prefinished boards	2600 x 190 mm 2600 x 290 and 2600 x 590 mm	[illegible]	[illegible]	[illegible]
Acoustic panels	veneered: 590 x 590 mm 1190 x 590 mm melamine faced: 2660 x 290 mm	18 mm	[illegible] resistance	[illegible] (BS 5669: 1979) and V 100 (DIN 68763)
Dry wall system	600 x 2600 mm 600 x 2700 mm	18 mm Total wall system: 95, 120 & 130 mm	Thickness tolerance	±0.3 mm
			Surface screw retraction	95 N/mm
	[1] other sizes, thicknesses and cut sized to order		pH value	9–10

Iives Mineral basic boards, prefinished and acoustic panels and the wall system are available faced with high pressure laminates, painting film, and also primed. Real wood veneers are available in pine, beech oak and birch. Melamine finishes are available in pine, oak and birch. Both with other grains to order.

Fire classification:

In UK:
Class 1 Surface spread of flame (BS 476: Part 7:1971)

Class 0 Fire propagation (BS 476: Part 6:1968)

In Germany:
Schwerentflambare Baustoffe B 1

France: M1

Netherlands:
Contribution to fire propagation class 1

For further information see also Iives Mineral Technical Manual.

Manufactured by:

METSÄ-SERLA
Häme Mills

Sales:

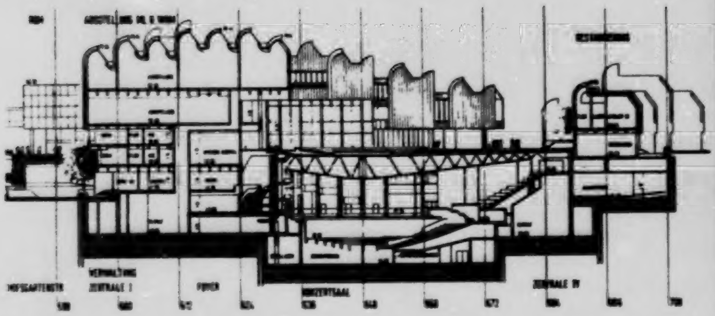
Metsä-Serla Oy
Panel Products Division
Aulangontie 51
SF-13210 Hämeenlinna
Finland
Tel. Int. +358-17-256 11
Telex 2312 mhmi sf
Telefax +358-17-121060

Finnforests Ltd
Forest House
3, Albemarle Way
London EC1V 4PS
England
Tel. Int. +44-1-251 2671
Telex 25225 forest g
Telefax +44-1-251 2677

Finnforest GmbH
Fischerstrasse 45
D-4000 Düsseldorf 30
Bundesrepublik Deutschland
Tel. Int. +49-211-494 015
Telex 8584474 wald d
Telefax +49-211-466 593

Printed in Finland by [illegible]

[illegible]-Brand
En optimal lösning
för ett
krävande byggobjekt



Kulturcentret i Köln tysk nutidsarkitektur när den är som bäst. Ilves-Brand håller måttet.

Kulturcentret i Köln blev en utmaning för dess projektörer. Centret byggdes på den smala landtungan mellan domkyrkan och Rhen. En massivt dimensionerad byggnad skulle ha dragit uppmärksamheten från stadens symbol, domkyrkan. Ändå ville man göra kulturcentret till ett ståtligt monument över nutidens tyska arkitektur.

Vid planeringen och uppförandet har man lyckats kombinera dessa två ytterst motstridiga krav. Kulturcentret är en sevärdhet. Det är monumentaliskt även med avseende på dimensionerna. I kulturcentret finns bl.a. två museer och en konserthall för 2 200 besökare. Golvarealen är sammanlagt ca 22.800 m². Projektets kostnad uppgick till 1 mrd. kr.

I kulturcentrets konserthall finns Ilves-Brand. Ytbeklädnaden i hallens väggar loger och trappuppgångar består av Ilves-Brand, fanerad med Amerikansk rödek. Valet föll på Ilves-Brand beroende på höga miljökrav, på skivornas utomordentliga akustiska egenskaper och dess formbarhet.

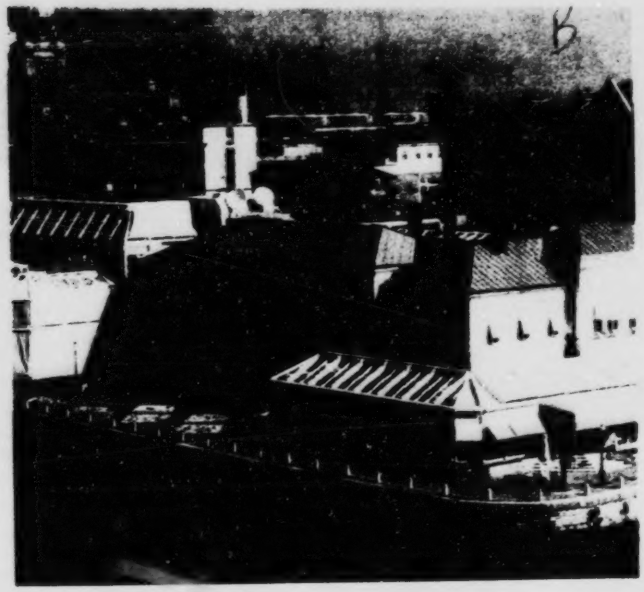
Artitekt: Busmann och Haberer
Byggherre: Köln Stad.
Snickeriarbeten, inkl. bl.a. fanering samt
montering av Ilves Brand: Skellefteå Snickericentral AB

Gemensamt för Börshuset i Malmö och Sheraton i Göteborg – Ilves-Brand

Ilves-Brand har framgångsrikt använts, både vid nybyggnad och vid ombyggnad. Börshuset i Malmö är ett bra exempel på en lyckad ombyggnad. Den gamla, restaurerade delen, som har återfått sitt ursprungliga utseende, bildar nu en harmonisk helhet med den hypermoderna nya delen av huset. Gammalt och nytt har kombinerats fördomsfritt, men skickligt.
Byggnaden betjänar nu såväl inhemska som internationella gäster, bland annat som säte för möten och kongresser.

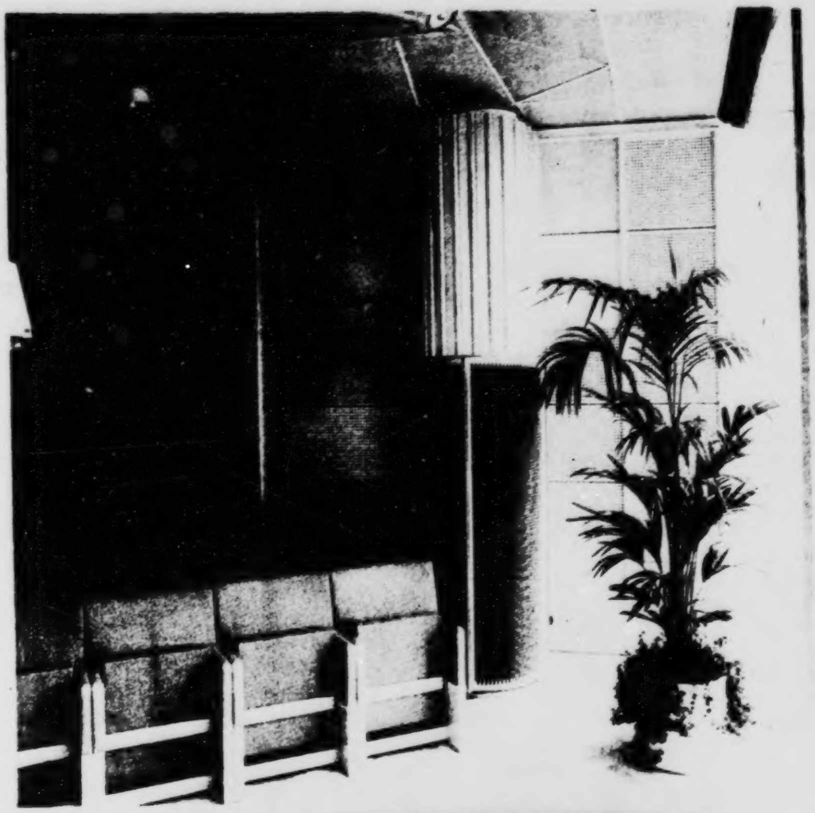
Stora börssalen är den viktigaste lokalen i den nya delen. Till denna sal valdes en beklädnad av björkfanerad Ilves-Brand. Det var estetiska, tekniska och ekonomiska faktorer som låg till grund för valet.

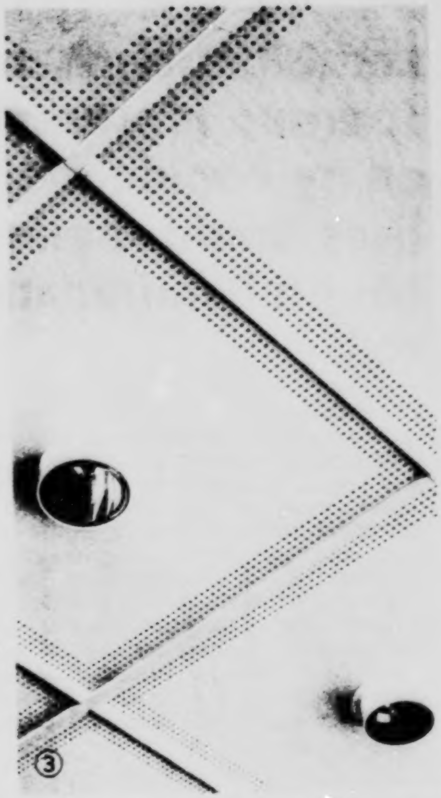
I hotell Sheraton i Göteborg har Ilves-Brand använts på ett nytt intressant sätt. Skivan har valts bl.a. till yttre beklädnadsmaterial i den täckta innergården. På så sätt har man skapat en enhetlig, visuell inomhusstämning i hotellets vinterträdgård.



Bilderna 1, 2, 3, Börshuset i Malmö.
Arkitekt: Nils P. Johansson, Tage Møller Arkitektbyrå AB Malmö.
Byggherre: Malmö Börshus AB.
Montering av Ilves Brand paneler och akustikskivor: PEAB, Förslöv

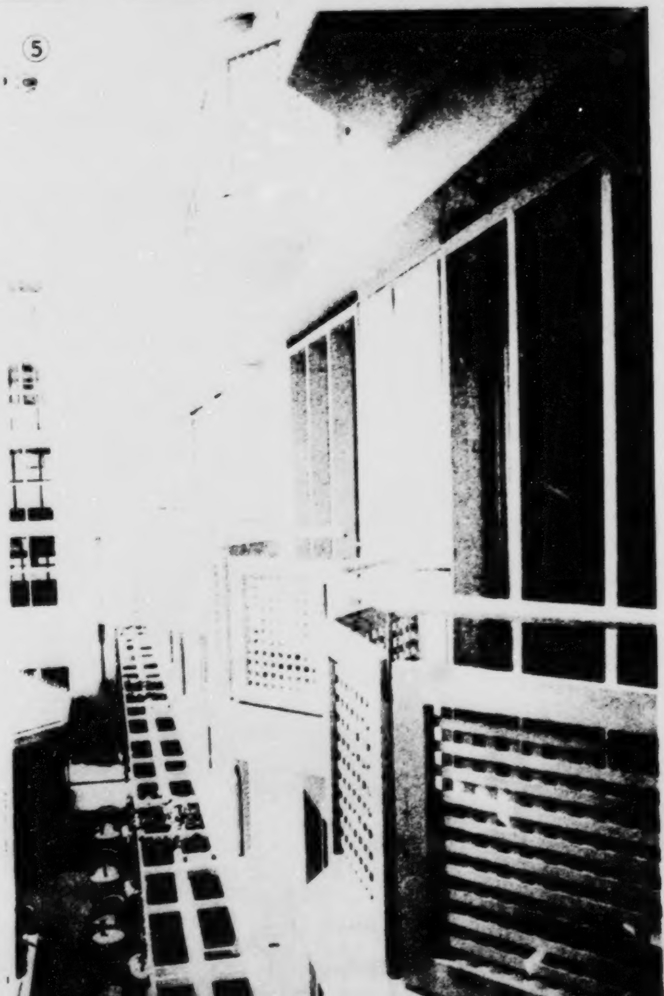
Bilderna 4, 5, 6, Hotell Sheraton i Göteborg.
Arkitekt: Lund och Vallentin, Göteborg
Byggherre: Ab Huvudstaden.
Fanering och montering av Ilves-Brand: Sävar Snickeri AB, Sävar.





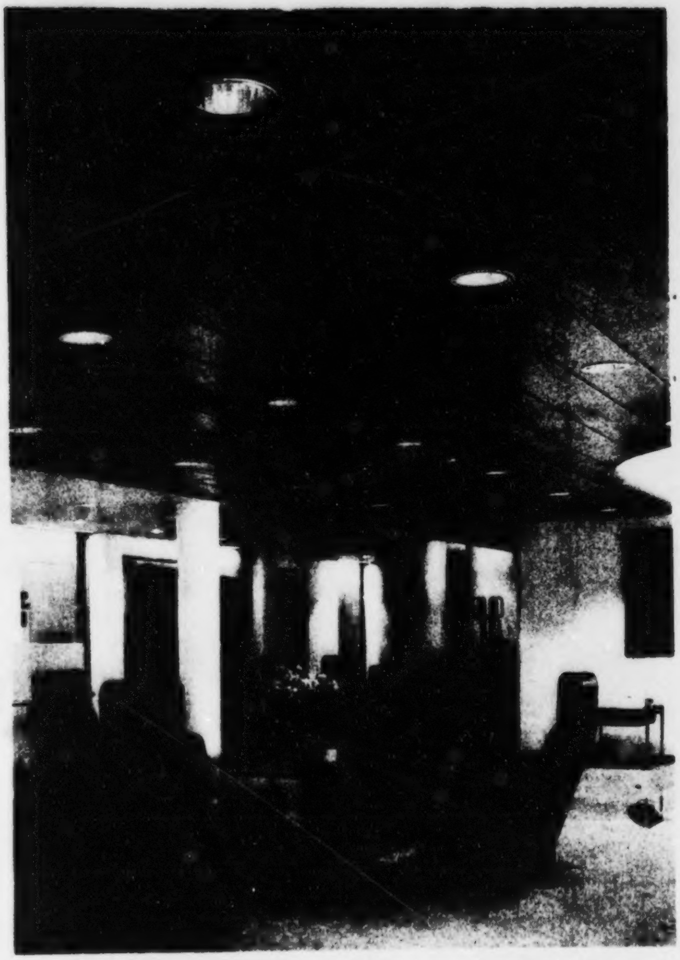
③

⑤



⑥

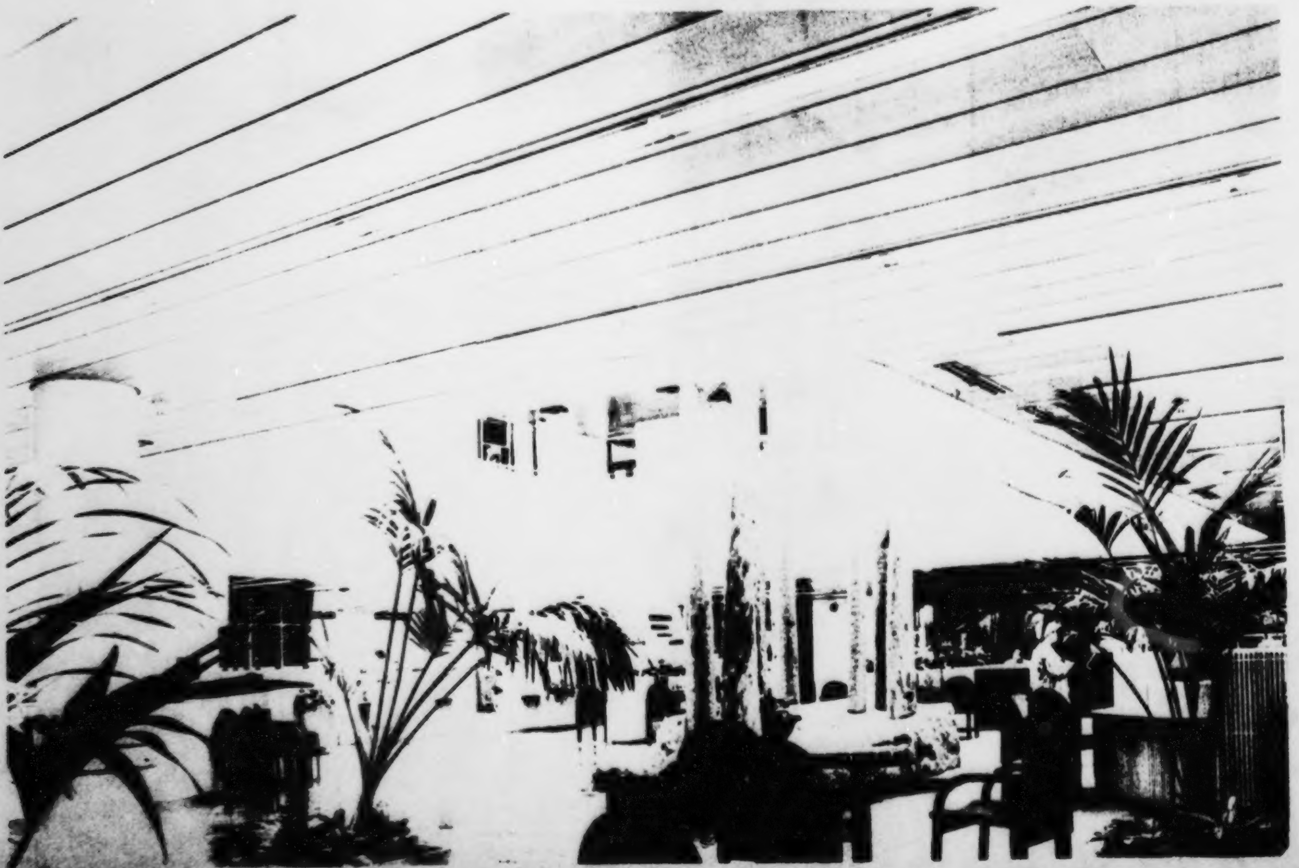
Landskapsbanken i Joensuu representerar en ny bankarkitektur. Ilves-Brand spelar här en framträdande roll.

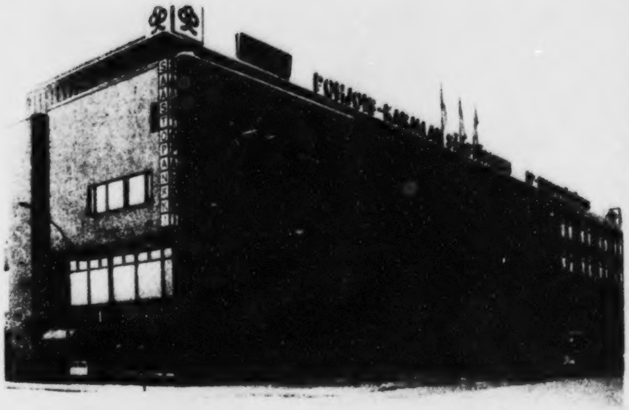


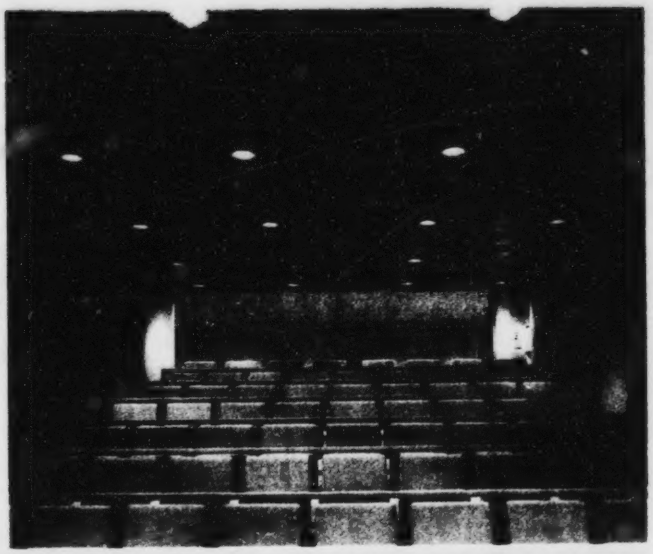
Landskapsbankens hus i Joensuu Finland är ett representativt Ilves-Brand-objekt. Bankbyggnadens arkitekter utgick från att skapa något nytt, en bank som avviker från den traditionella banken. Genom val av material och färgsättning har man frammanat Nordkarelens anda och väsen.

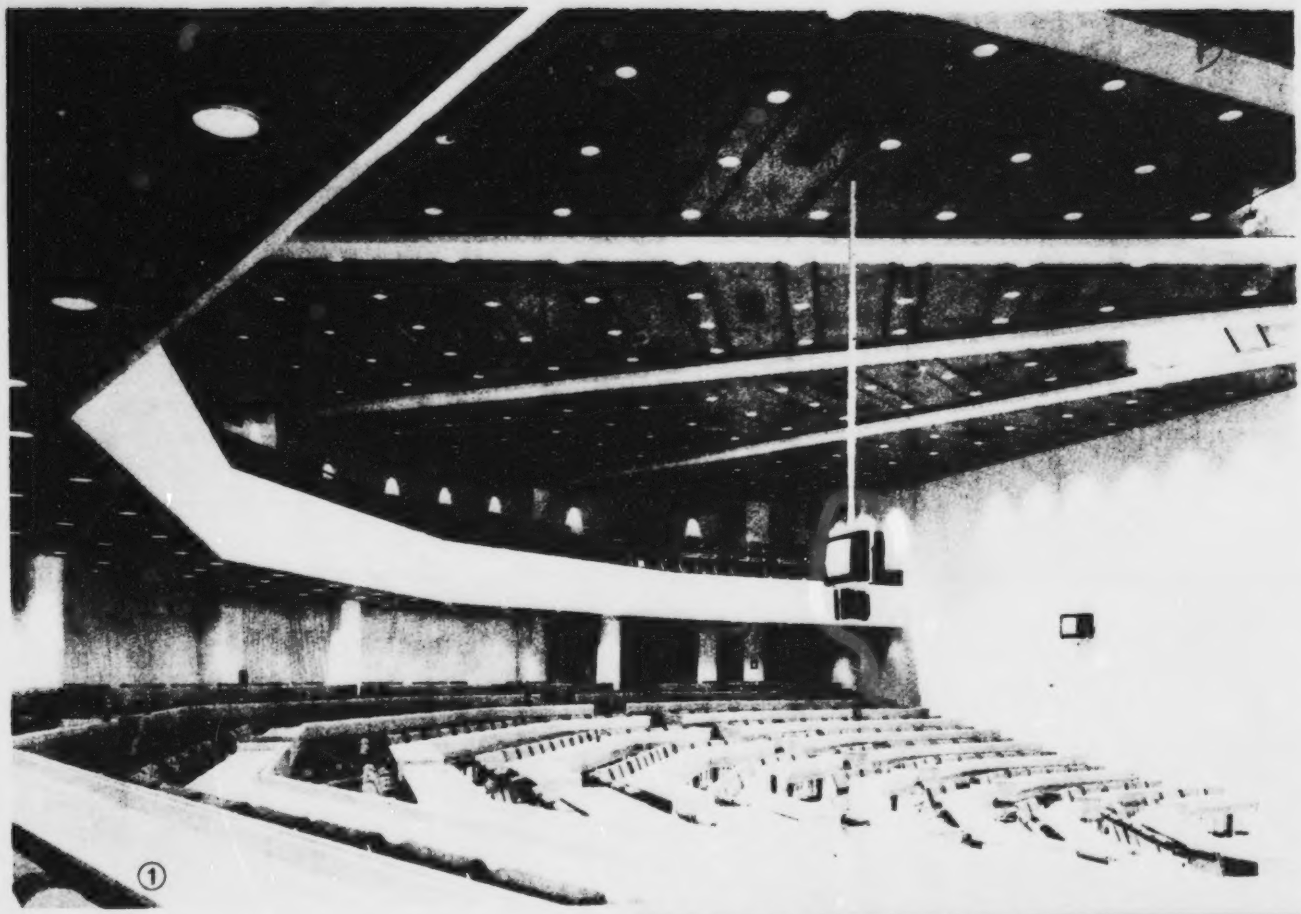
I inredningen märks detta på valet av material och deras inbördes kombinationer. Golvet är av rödsvart granit och takytorna är klädda med Ilves-Brand fanerad med rödbok. I varje rum är Ilves-Brand med och skapar bankhusets interiörer – i själva banklokalen, i konferensrummen, i aulan och trapporna. Ilves-Brand står för en väsentlig del av andan och stämningen i Landskapsbanken i Joensuu.

På bilden Pohjois-Karjalan Säästöpankkis landskapsbanks hus.
Arkitekt: Arkkitehtuuritoimisto E K Malmivaara Ky
Byggherre: Pohjois-Karjalan Säästöpankki
Montering av Ilves-Brand: Rakennustoimisto
Y I Immonen Oy




SAASTOPANKKI



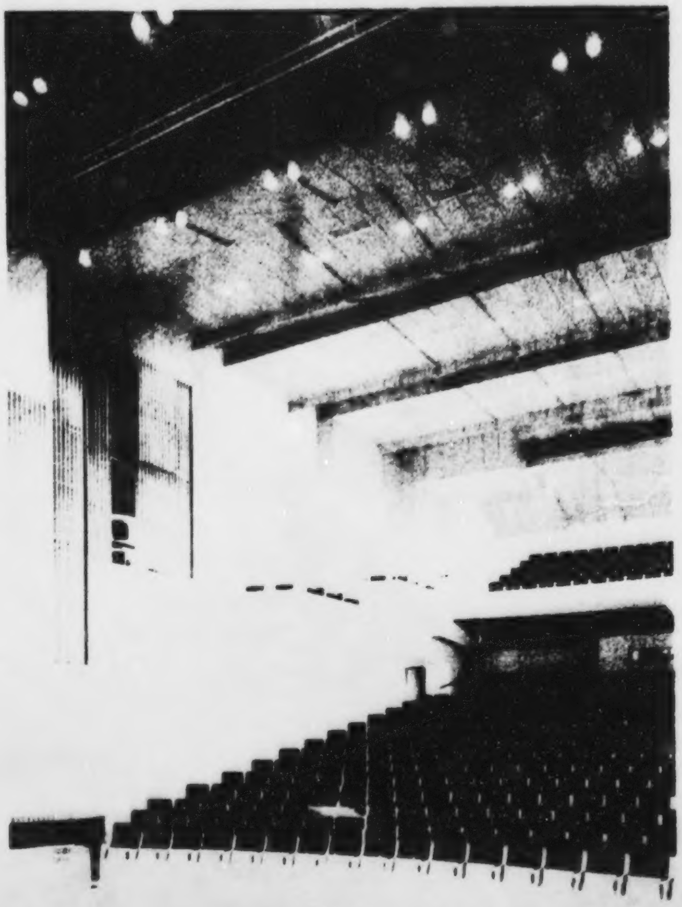


①

Ilves-Brand har sin givna plats i offentligt byggande.

Ilves-Brands talrika och mångskiftande användningsändamål berättar om dess stora flexibilitet. Användningsområderna sträcker sig alltifrån konsertsalar till hotell från idrottshallar till församlingscentra och vårdcentraler.

1. Turkistuottajat Oy:s auktionssal, Fur Center i Vanda
   Ilves-Brand fanerad med rodbok.
2. Kulturcentret i Imatra
   Ilves-Brand fanerad med bjork.
3. 5. Outokumpu Engineering Oy:s affarshus i Esbo
   Mörkbetsad Ilves-Brand fanerad med ek.
4. S:ta Maria kyrkan i Helsingfors
   Ilves-Brand fanerad med ek.
6. Läkarcentralen i Åbo
   Ilves-Brand belagd med bjorkmelamin.



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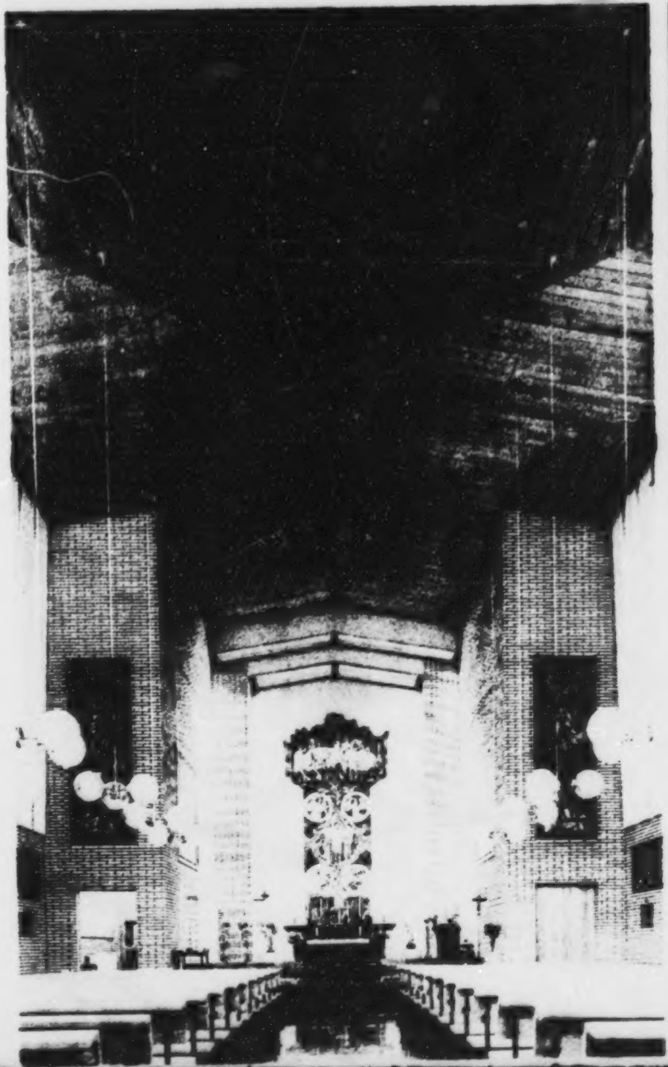
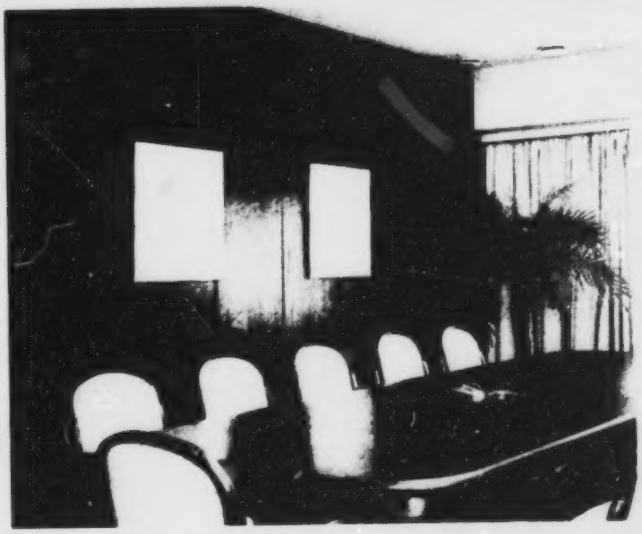




⑥

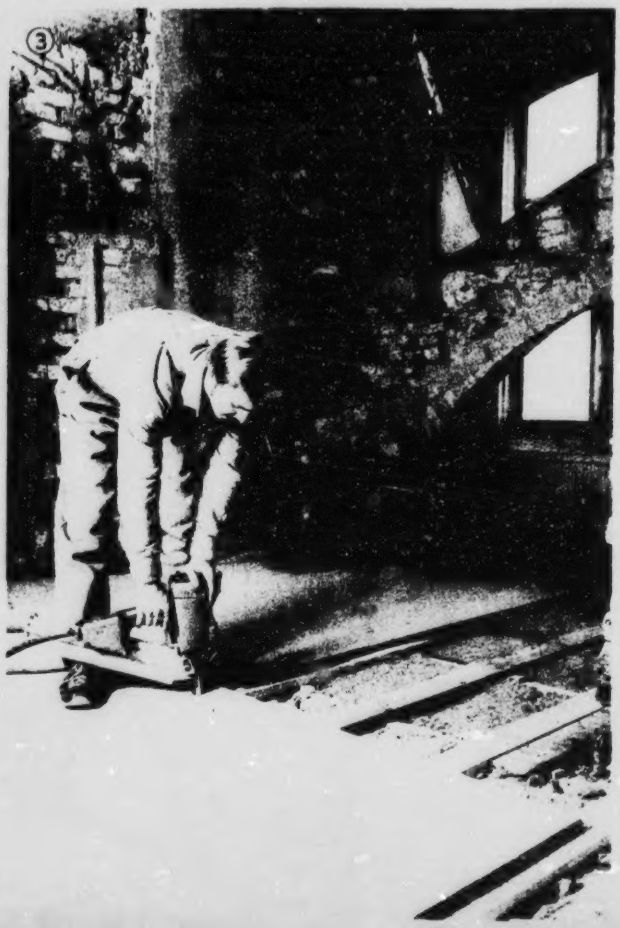
Ilves-Brand är en stark och hållfast skiva

Ilves-Brand är ett produktprogram för krävande byggnadsändamål. Basskivan består av rent trä och specialcement. Ilves-Brand är slag- och fukttålig, brandsäker och effektivt ljudisolerande.

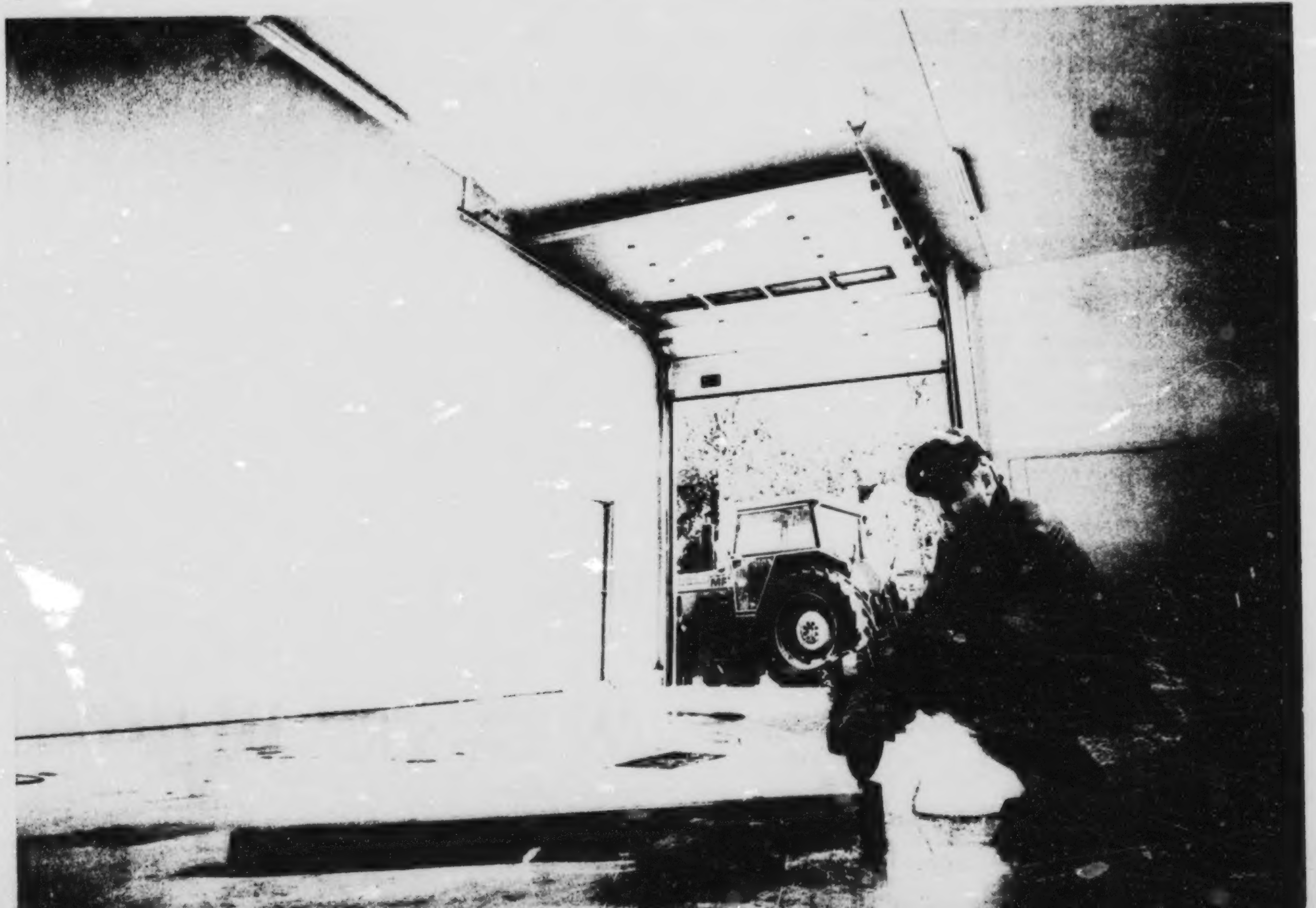
Ilves-Brand kan användas från golv till tak vid ny- och ombyggnad. Den lämpar sig också väl för industrielllt bruk och som basmaterial i specialgolv.

Bilderna:

1. Makrotalos fabrik i Kankaanpää. På denna linje görs golvelement till byar som skall byggas i västra Sibirien för 8 000 människor, och till staden Jamburg som skall byggas för 9 000 invånare vid. Ob-flodens delta.
2. Televerkets station i Göteborg har 680 m² golv av Ilves-Brand Finndata Type II.
3. Renoveringsobjekt Apotekshuset i Abo.
4. Aki-hallen hos Hankkija har fått väggarna beklädda med Ilves-Brand.



MAKRO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Komprimerad information om Ilves-Brand programmet

	Standardmått*)	Standardtjocklek
Ilves-Brand Standard	1200 x 2600	8, 10, 12, 15, 18, 22, 25 och 32
Ilves-Brand Panel	2600 x 190 2600 x 290 2600 x 590	12 mm
Ilves-Brand Ytbelagd	2600 x 1200	8...18 mm
Ilves-Brand Akustik	Belagd med faner: 590 x 590 mm 1190 x 590 Med melaminfolie: 2600 x 290	12 mm
Ilves-Brand Mellanvägg	600 x 2600 600 x 2700	12 mm notad Ilves-Brand (Väggens totaltjocklek 95, 120 och 130 mm)
	*) Andra mått och tjocklekar fås på beställning.	

Tekniska egenskaper	
Volymvikt:	1200...1400 kg/m³
Böjhållfasthet:	12...14 N/mm²
Tvärdraghållfasthet:	0,3...0,6 N/mm²
Elasticitetsmodul:	4000...5000 N/mm²
Längdsvällning vid luftfuktvariationer: RH 35...90 %	0,2 %
Tjockleksvällning i 2 h vattenbad:	1...3 %
Fukthållfasthet:	Motsvarar fuktbeständig spånskiva: V-313 NF B 51-263 och V-100 DIN 68763
Tjocklekstolerans:	± 0,3 mm
Övriga mått-toleranser:	Engligt standard SFS 3515
Skruvutdraghållfasthet i skivans yta:	95 N/mm
Skivytans pH:	9...10

Kantutformingen är anpassad till de vanligaste montagesätten. Ilves-Brand Panel har notade långsidor. Ilves-Brand Standard, Ytbelagd och Akustik har grada kanter men kan även erbjudas med notade kanter.

Ytbeläggningar:

Ilves-Brand, Panel, Ytbelagd och Akustik samt Mellanvägg finns att få belagda med laminat, film, fenolfilm eller målad
Därutöver med äkta faner; fur, ek, bok och björk samt andra träslag på beställning.
Finns även belagda med melaminfolie; fur, ek och björk som standard.

Brandklassificering

Ilves-Brand är typgodkänd i Sverige av Statens Planverk som
- Svårantändligt material
- Tändskyddande beklädnad med ytskikt klass I,

i Norge av Statens Branninspeksjon som
- Tennvernende kledning A10, och

i Danmark av Boligministeriet som
- Klasse 1 beklaedning
- Klasse A material.

Försäljning:

PLYFA

AB Plyfa
Box 224, 20122 Malmö
Tfn 040-93 47 40
Telex 32179
Stockholmskontor:
Tfn 08-45 48 36, 45 48 56

Tillverkning:

METSÄ-SERLA

Hämeen Tehtaat
Aulangontie 51, 13210 Hämeenlinna,
puh. (917) 256 11/vaihde, telex 2312 mhml sf,
telefax (917) 121 060

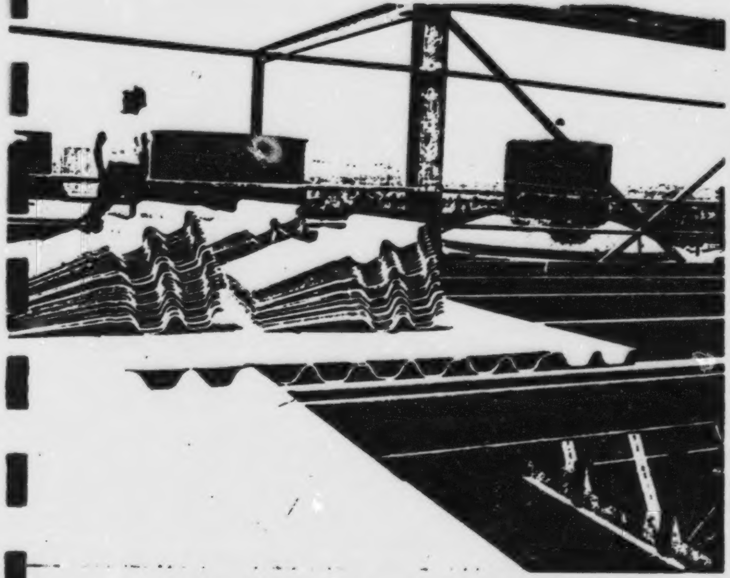
My Ylikoinen/Tamprint -87

APPENDIX IX

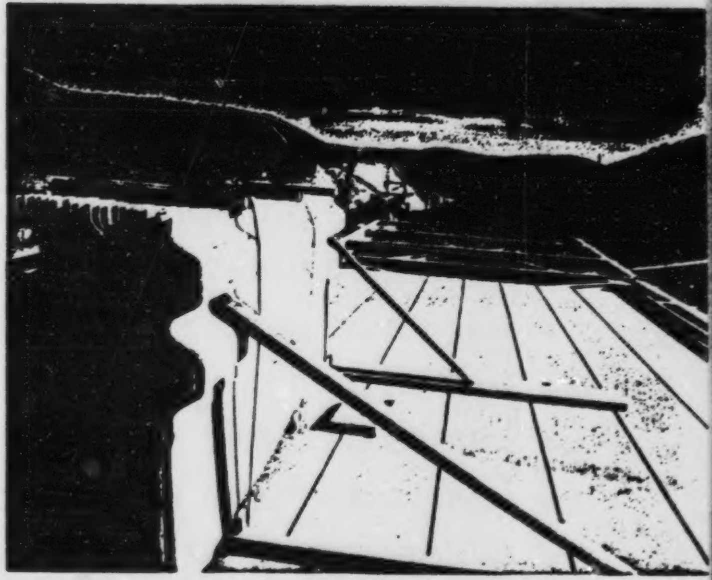
ATLAS T-ROOF - PROMOTIONAL MATERIAL

Tabliers de toits en amiante-ciment

MATERIAUX
DE CONSTRUCTION
ATLAS



Tablier "T" sur le toit de la Compagnie Scott Paper, de Nackawick, au Nouveau-Brunswick.

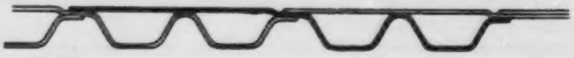


130,000 pieds carrés de tabliers de toits Atlas ont été installes à Boise Cascade, Rumford, Maine.

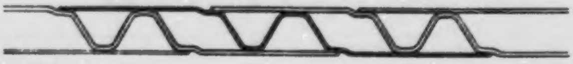
- Ont fait leur preuve face à la plupart des atmosphères corrosives
- Ne se détériorent pas face à un haut degré d'humidité
- Économiques, légers, de pose rapide et facile
- Incombustibles
- Résistants et durables
- Système "factory mutual"

Tabliers de toits

Les fibres d'amiante sont utilisées pour renforcer les tabliers de toits Atlas leur donnant toutes les qualités naturelles à l'amiante-ciment. Les fibres d'amiante sont liées et encapsulées dans le ciment empêchant leur propagation dans l'environnement. Une bonne précaution est d'éviter de scier les produits amiante-ciment à sec, à haute vitesse et sans un système d'aspiration.



Tablier "T"



Tablier "Cavity"

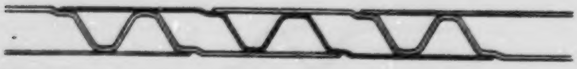
Les tabliers de toits Atlas ont fait leur preuve.

30 ans d'expérience – Plus de 200 millions de pieds carrés installés au Canada et aux États-Unis.

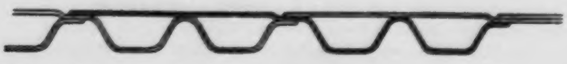
Des champs d'activités diverses:

- usines de pâtes et papier
- usines pétrochimiques
- usines de phosphate
- usines de potasse
- usines de ciment
- usines d'engrais
- usines de tabac
- usines de traitement du poisson
- et une variété de mines

	TABLIERS "CAVITY"		TABLIERS "T"	
	Impériale	**Métrique**	**Impériale**	**Métrique**
Longueur	sur demande		sur demande	
Longueur maximale	10'10"	3302 mm	10'0"	3048 mm
Largeur totale	3'7-⅛"	1095 mm	3'7-⅝"	1108 mm
Largeur utile (à la pose)	15"	381 mm	21"	533 mm
Profondeur hors tout (à la pose)	4 11/16"	119 mm	4"	102 mm
Épaisseur nominale du matériau	⅜"	9,5 mm	⅜"	9,5 mm
Capacité de recouvrement (longueur de la feuille)	12.5 pi^2 (10'0")	1,16 m^2 (3048 mm)	17.5 pi^2 (10'0")	1,63 m^2 (3048 mm)
Poids d'un élément (longueur de la feuille)	137 lb (10'0")	62,14 kg (3048 mm)	145 lb (10'0")	65,8 kg (3048 mm)
Poids du tablier (à la pose)	11 lb/pi^2	53,7 kg/m^2	8.3 lb/pi^2	40,5 kg/m^2
Appui minimum aux extrémités	2"	51 mm	2"	51 mm



Tablier "Cavity"



Tablier "T"

Résumé de mode d'application – Tabliers "Cavity" et "T"

Mode d'application/Type de solive

Les tabliers "Cavity" et "T" peuvent s'appliquer de la gauche vers la droite ou vice versa, sur des solives en acier, en béton ou en bois.

Ancrage sur les supports

Les tabliers "Cavity" et "T" sont maintenus en place par des vis, des vis auto-taraudeuses ou des boulons. Avec un toit nominalement plat, le tablier "Cavity" peut être maintenu en place par des pinces métalliques. Chaque extrémité de chaque feuille doit être ancrée sur les supports.

Début de la pose

Le tablier "Cavity" nécessite une feuille non coupée pleine largeur, et deux feuilles de largeur réduite.
Le tablier "T" nécessite une feuille non coupée pleine largeur et une feuille de largeur réduite.

Largeur utile/Changement de direction

La largeur utile du tablier "Cavity" seulement peut être réduite jusqu'à un minimum de 12".
La direction du tablier "Cavity" seulement peut être changée de 2°.

Coupe, limage, façonnage et perçage

Les tabliers "Cavity" et "T" peuvent être coupés, limés, façonnés et percés tout en respectant les précautions normales lorsqu'on manipule de l'amiante-ciment. Des brochures décrivant les méthodes de travail conseillées sont disponibles sur demande.

Avant-toit

Le porte-à-faux maximum pour les tabliers "Cavity" et "T" est de 1'0". Si un plus grand porte-à-faux est requis, on doit utiliser une construction de type cantilever. Les panneaux sous-face Atlas ne sont disponibles que pour les tabliers "T".

Mur garde-fou/Bordure de lanterneau

Les tabliers "Cavity" et "T" doivent être supportés de façon adéquate. Un support minimum de 2" est requis à chaque extrémité de tablier.

Pente de drainage

La pente de drainage des tabliers "Cavity" et "T" peut être obtenue en modifiant le niveau de la sous-structure ou en utilisant du béton de remplissage.

Joint de dilatation

Il n'est pas nécessaire de prévoir de joint de dilatation dans le sens de la longueur des tabliers, mais peut être prévu dans le sens de la largeur des tabliers.

Finition de plafond

Le plafond du tablier "Cavity" peut être utilisé sans aucun apprêt, mais si on le désire, il peut être peinturé. Le sous-toit du tablier "T" est lisse et forme des caniveaux réguliers.
Une grande gamme de plafonds suspendus peuvent être adaptés aux tabliers "Cavity" et "T".

Préparation pour toiture multi-couche

On applique directement sur les tabliers "Cavity" et "T" l'isolant rigide conventionnel ou les toitures multi-couches.

Conduit électrique et réseau de distribution

Les cavités des tabliers "Cavity" et "T" peuvent être utilisées pour loger les câbles électriques ou les réseaux de distribution.

Tuyaux

Des ouvertures jusqu'à 6" de diamètre peuvent s'adapter aux tabliers "Cavity" et "T".

Charges suspendues

Les charges excessives exigeront leur propre soutien.

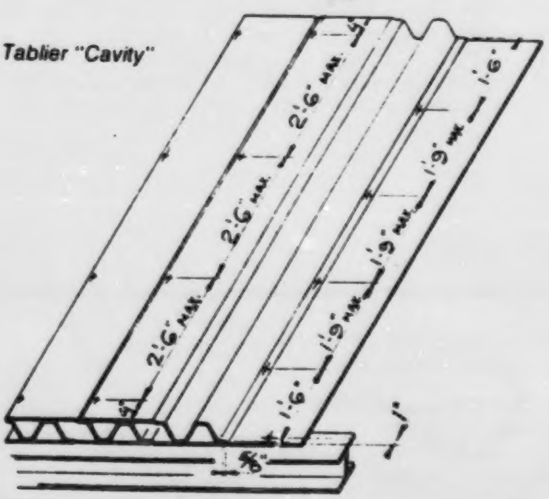
Remplacement de feuilles

Les feuilles situées au centre d'un toit peuvent s'enlever et/ou se remplacer facilement.

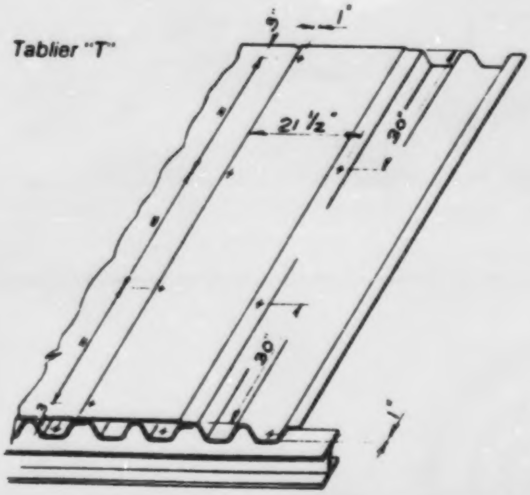
Restriction

Le rapport portée/charge pour chaque genre de tablier est disponible dans le Catalogue de Tabliers Atlas.

Tablier "Cavity"



Tablier "T"



MATERIAUX
DE CONSTRUCTION
ATLAS

Avantages

Peut être installe sans avoir besoin de fermer l'usine.

Legers, de pose rapide et facile.

Se sont révélés excellents face à la plupart des atmosphères corrosives

Durant de nombreuses années les tabliers de toits "Cavity" et "T" ont démontré qu'ils pouvaient faire face avec succès à la majorité des atmosphères corrosives. Leur solidité à tout épreuve et leur résistance les rendent un matériau de choix pour les industries spécialisées.

Ne se détériorent pas face à un haut degré d'humidité

Le tablier de toit Atlas en amiante-ciment n'est pas sujet à la pourriture, ni à la rouille. Il résiste à la corrosion et étant à l'épreuve de l'humidité il est recommandé pour la construction d'édifices où l'on rencontre un haut degré d'humidité.

Économiques, légers, de pose rapide et facile

Le transport sur des grandes distances des tabliers de toits Atlas n'est pas onéreux. Sur le chantier ils se coupent et se façonnent facilement. Les grands panneaux entrant dans les systèmes de murs et de toitures en amiante-ciment se posent rapidement avec un minimum de main-d'oeuvre. Ils peuvent être installés en toute saison sans avoir besoin de fermer l'usine.

Incombustibles

Les tabliers de toits Altas sont incombustibles et n'entretiennent pas la combustion. On les sélectionne largement pour les constructions exposées à des risques d'incendie.

Résistance et Durabilité

Les fibres d'amiante et le ciment Portland sont parmi les matières les plus résistantes en existence. Une fois combinées, elles dureront des décennies sans besoin d'entretien.

Système "Factory Mutual". Conclusions

Épreuve d'incombustibilité et de résistance au soulèvement par le vent. Utilisation approuvée comme tabliers de toit incombustibles ne nécessitant pas l'installation d'un système d'arrosage d'incendie. NOTA: des éléments de toiture combustibles de type Lavonia ont été utilisés pendant les essais.

MATÉRIAUX DE CONSTRUCTION ATLAS
une division d'Atlas Turner Inc.

5600 Hochelaga, Montréal,
Québec H1N 1W1
Telex: 05-828769
Tel.: (514) 259-2531

ASBESTOS CEMENT ROOF DECK

for

NONCOMBUSTIBLE ROOF DECK CONSTRUCTIONS

from

ATLAS TURNER INC.
5600 HOCHELAGA STREET
MONTREAL, QUEBEC H1N 1W1

SERIAL NO. 18481
JULY 19, 1968

FACTORY MUTUAL ENGINEERING ASSOCIATION

1151 BOSTON-PROVIDENCE TURNPIKE, NORWOOD, MASS. 02062

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I ABSTRACT

Atlas Turner Inc., submitted their Cavity and ''T'' decks for fire and wind tests to determine if these decks would meet the FM approval requirements for a Noncombustible roof deck construction.

Tests show Atlas Turner Cavity and ''T'' decks meet the FM approval requirements and are classified Noncombustible.

II TESTS

Tests conducted were as required by the Factory Mutual Standards for Classification of Noncombustible Roof Deck Construction.

A Fire Hazard

The fire hazard tests were conducted using the FM Construction Materials Calorimeter. See attached reprint for a general description.

B Wind Uplift

The wind uplift test utilizes a 9 ft long x 5 ft wide x 2 in. deep steel pressure vessel arranged to apply air pressure at pre-established standard rates to the underside of the test panel which forms the top of the pressure vessel.

To pass this test successfully, there must be no separation of any bond between the insulation board and the roof deck, up to and including 60 psf.

III MATERIAL TESTED

	Cavity Deck	"T" Deck
Materials	Asbestos-cement	Asbestos-cement
Thickness of units	3/8 in.	3/8 in.
Width of units	3 ft-7 1/8 in.	3 ft-7 5/8 in.
Maximum span of units	10 ft	8 ft
Overall depth of units	4 11/16 in.	4 in.

IV TEST PANELS

The test panels were assembled as follows:

A Fire Panels

Two 4 1/2 ft x 5 ft test panels were constructed; one with Cavity roof deck and the other with "T" deck.

Both decks were assembled with a maximum of combustibles above to evaluate any possible fire spread on the underside of the roof due to heat contribution down through the deck joints.

These combustibles consisted of a 2 ply - 3 mop vapor barrier (15 lb asphalt saturated felts) and a wood fiberboard roof insulation, 1 in. thick. The felts were secured to the deck and between each ply with hot asphalt at an application rate of 25 lb/sq in each mopping. The insulation was secured to the felt vapor barrier with hot asphalt at 25 lb/sq.

B Wind Uplift Panels

Two 9 ft x 5 ft test panels were constructed, one with Cavity roof deck, and "T" roof deck in the other.

Both decks were insulated above with 1 in. wood fiberboard roof insulation which was secured to the roof deck with a minimum quantity of hot asphalt (12 lb/sq). A conventional 3-ply built up roof covering was mopped on the insulation.

V RESULTS

A Fire

These roof decks performed satisfactorily with no flaming or burning observed from the combustible vapor barrier, roof insulation, or asphalt during the test period.

The flue temperatures recorded during the 30 min. Calorimeter tests showed no heat contribution through the Cavity or "T" decks.

	MAXIMUM AVERAGE RATE OF HEAT CONTRIBUTION (BTU/FT^2/MIN) FOR VARIOUS INTERVALS OF TIME			
	3 Min.	5 Min.	10 Min.	Average
Class I Standard	385	365	340	270
Cavity Deck	0	0	0	0
"T" Deck	0	0	0	0

B Wind

The Cavity and "T" roof decks maintained their rigid characteristics during construction of the test panels and throughout the test procedure.

Both wind uplift panels exceeded the 60 psf minimum Factory Mutual requirement for adequate wind uplift resistance.

VI CONCLUSIONS

A Test results show Cavity and ''T'' roof decks by Atlas Turner Inc., meet the Factory Mutual Standard as Noncombustible roof decks.

B Cavity and "T" decks are approved for use with any woodfiber roof insulation, felt vapor barrier, coal tar pitch and asphalt adhesive or other conventional roofing materials.

C Where these deck constructions are used in conjunction with a noncombustible supporting structure, automatic sprinklers may be omitted where permissible under the standards of the Factory Mutual Engineering Association.

D Continuation of approval will depend upon satisfactory field experience.

VII MANUFACTURER'S RESPONSIBILITY

A The manufacturer shall notify the Factory Mutual Engineering Association of any change in the product tested prior to its general sale and distribution.

B The manufacturer will make every reasonable effort to supply all necessary instructions and other assistance to the roofer to ensure a proper roof installation.

****

Approval is effective when the Manufacturer's Agreement is signed and returned to Factory Mutual.

CFT/jb

TESTS BY	: W. F. Maroni : C. F. Tuells : A. L. Borman
REPORT BY	: C. F. Tuells
NOTEBOOK NO.	: 250-272-259
ATTACHED	: Reprint

APPLICATION INSTRUCTIONS

ATLAS Asbestos-Cement "T" DECK

GENERAL: These general application instructions were prepared to guide contractors in the installation of Atlas Asbestos-Cement "T" Deck. They are not intended, however, as a substitute for competent engineering or architectural judgment based on first-hand knowledge of special conditions.

Atlas Asbestos Company provides complete Specification Guides, Product Data Sheets and Typical Detail Drawings which may be of use to contractors in applying this or other Atlas materials. Refer to Atlas forms: AA 3233, 3374, 3384; available from any Atlas Office or Representative or write direct to Specification Service, Atlas Asbestos Company, 5600 Hochelaga St., Montreal 426, Quebec, Canada.

SUPPORTS: Joists or other intermediate supports should be 4" minimum in width, so as to provide a bearing of not less than 2" at each end of the unit. They may be of steel, timber or concrete and should be parallel at appropriate centres according to the length of unit to be employed. The top of all joists or packings thereon should be level or conform to the required fall in the roof surface. It is desirable to check side overlapping with a suitable 21" gauge. For spans below 8'0" the bearing may be reduced to a minimum of 1½" subject to prior discussion with and recommendation by Atlas Asbestos Company.

FIXINGS AT SUPPORTS: On nominally flat roofs every third unit should be secured to the supporting joists or bearer with a self-tapping screw (#14 x 1" Type B, S.T. Screw Cd. Plated). If supports are concrete, fixing grounds should be embedded continuously or at intervals of 5'3" for screw attachment. In all cases the screw or bolt penetrates the lower member of the unit and is thus concealed in the cavity. On sloping roofs positive attachment by self-tapping screw or bolt is necessary as follows:

0° to 10° one direct fixing each end of every 3rd unit.

10° to 20° one direct fixing each end of every 2nd unit.

Over 20° one direct fixing each end of every unit.

DIRECTION OF LAYING: "T" Deck may be laid from left to right or vice versa whichever is considered the more convenient. Wherever the underside of the decking is to be left exposed it is desirable where practicable to arrange the layout of the units to provide symmetry and balance in the ceiling joints and to ensure that by correct gauging the straight continuous lines of the troughs are maintained well.

STARTING THE ROOF: Unless dictated by special design of the eaves or of verge overhang or by particular consideration of the position of the ceiling troughs, the roof should be started with a full width uncut overlapping unit and one reduced width supporting unit as shown on Detail 2.

Wood fixing blocks, 12" long minimum, if required for starter sheets or fascias should be supplied and fixed by the roof deck applicator. For starting, cut off 21" width of the flat part of the first unit and using the remaining configurated or trough section, align this with the extremity of the roof (e.g.; with eaves, verge or abutment) and provide continuous support for the cut edge with wood block or similar.

Secure the cut sheet to supporting roof structure. Taking the next full width unit, lay this to overlap the starter and similarly align with the cut edge at the extremity of the roof and secure the edge with wood screws, self-tapping screws, or bolts, according to the type of edge support employed.

These fasteners should be set at 3" from the end of each unit with intermediates equally spaced, viz; at 2'6" o/c for an 8'0" unit and correspondingly closer for shorter length units. See Table 1 below.

TABLE 1. ASSEMBLY FIXINGS — DRILLED HOLE LOCATIONS

UNIT LENGTH IN FEET	SPACING IN INCHES		TOTAL No. OF SELF-TAPPING SCREWS PER UNIT
	UNDER FLAP	TOP FLAP	
4	16 16 16	3 21 21 3	5
5	20 20 20	3 27 28 3	5
6	24 24 24	3 22 22 22 3	6
7	28 28 28	3 26 26 26 3	6
8	32 32 32	3 30 30 30 3	6

ASSEMBLY FIXINGS: Secure the first underlap. At 21½" from the overlapping edge of the full unit (i.e.; approximately in the centre of the unit) using a 3/16" size bit, drill 2 holes through both thicknesses of material comprising the underlap spaced at 2'6" from each end of the unit (for 8'0" units).

Enlarge the holes in the top thickness to ¼" diameter, countersunk to suit and secure with 1¼" No. 12 flat head "A" type self-tapping screws. A composite drill would simplify the operation. (Detail No. 3).

Lay the next full unit (using a 21" gauge) and immediately secure the underlap as before. At 1", clear from the overlapping edge of this unit, using a 3/16" bit, drill 4 holes through both thicknesses of the overlap, spaced at 3" from each end and equidistant in the length of the unit. Similarly enlarge the holes in the top thickness to ¼" diameter, countersink to suit and secure with 1¼" No. 12 gauge flat head "A" type self-tapping screws.

Proceed similarly with laying further units.

CUTTING: When sawing is required, lay the sheet flat on the work bench, or on planks laid across sawhorses, and cut with electric power driven saw, equipped with a carborundum wheel or a carbide tipped blade. We suggest Canadian Carborundum Company's ⅛" x 8" Silicone Carbide Resinoid Wheel, or equal, operated at a speed of 3,000 to 3,500 R.P.M., with portable or stationary power saws. A toothed blade 8" diameter should have 20 teeth with alternate bevel of 15°. These wheels or blades are available from Skil Tools Ltd., Toronto, Canadian Carborundum Company Limited, Niagara Falls, Ont., Norton Company of Canada Limited, Hamilton, Ont., and at most hardware dealers.

When heavy shop equipment is available, a 3/16" x 16" Carborundum Wheel operating at 3,500 R.P.M., and travelling at a speed of approximately 5 feet per minute will give the best results.

While the sheets can be saw cut with an ordinary cross-cut saw, the saw will dull rapidly and will require frequent sharpening. This method is therefore useful only for a limited amount of cutting. A little water on the saw will help the cutting.

LA COMPAGNIE
ATLAS ASBESTOS
COMPANY
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131 Brown's Line, Toronto, Ont. M8W 3S7 (416) 259-9281 Telex: 022-095
833 Cun[illegible] Ave., New Westminster, B.C. (604) 521-7751 Telex: 043-51133

Form AA4501/A Printed in Canada

For circular cuts or odd shaped small openings, lay out the shape to be cut on the material. Drill a series of small holes approximately ⅛" apart along the line of the cut and tap with a hammer to knock out the piece. For larger openings, first drill a hole on the circumference line as a starting point, and then cut out the piece using a keyhole saw.

Small rectangular holes may be made in the same manner by drilling a hole at each corner of the rectangle. A powered sabre-saw is ideal for smooth irregular curves, short straight cuts or perfect circles above one foot diameter using a radial arm attachment.

For rectangular cutouts in the centre of the sheet, and for interior straight line cuts, the electric power saw should be lowered to the surface of the sheet onto the cutting line to cut through the material from the top. The cut should be made as close to the corner of the rectangle as possible on all four sides. If necessary the piece may be knocked out with a sharp blow.

FILING AND SHAPING: Edges can be smoothed and filed true to line by the use of carborundum flocked steel file or wood-working rasp.

DRILLING: All holes must be carefully drilled. Under no circumstances should they be punched.

When drilling, use a portable high speed rotary electric drill. Standard twist drills of either high carbon or high speed steel may be used for holes up to 1¼" diameter; a standard boring tool and cutting bar for holes up to 2⅛" diameter and a fly-bar for larger holes. Drills will dull rapidly and should be sharpened frequently in the same manner as if being used for drilling steel.

For sheets up to ½" thick the drills should be ground as shown in Fig. 1.

IMPORTANT: The holes shall generally be pre-drilled 1/16" larger than the diameter of the fastener employed.

For larger holes and thicker material the angle of the cutting edge should be increased slightly, and the drill speed reduced. The heels of the lips should be backed off about 5 degrees less than the cutting edges, which is about the same as for the drilling of mild steel or cast iron.

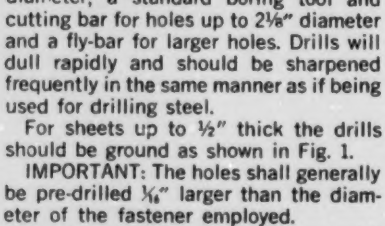


FIG. 1 DRILL GRINDING

Where possible and where a very clean hole is desired, a piece of wood placed directly underneath the hole being drilled will eliminate the possibility of the edges breaking away when the drill comes through the sheet. Care in drilling and the release of pressure for the last ⅛" will allow the drill to cut its way through without punching, if it is not practical to use a wood block.

SLOPING ROOF APEX AND VALLEYS. For sloping roofs where the apex or ridge is at right angles to the corrugations it is usual to fill the triangular void with concrete or cement grout. To accomplish this, it is necessary to close off the cavities with a strip of flat asbestos-cement or a strip of felt. (Detail No. 4).

For the less satisfactory and uncommon arrangement where the corrugations and ridge are parallel, the junction is made by cutting to suit.

EAVES: A typical eaves detail is shown in Detail No. 5.1 where the units are running at right angles to the overhang. In this case fixing blocks should be inserted in the centre corrugation of alternate units, i.e., at 2'6" centres to which a wood fascia and metal flashing can be screwed. The maximum UNSUPPORTED overhang is 1'0".

WIDE EAVES: A greater overhang parallel to the units can be achieved by extending cantilever brackets from the roof beams, of T or double angle section up to 4" deep, concealing the web and exposing only the flange on the underside. (Detail No. 5.2). Where overhang is across the run of the units the cantilever brackets should be below the deck exposed or boxed in (to choice) to avoid excessive cutting of the deck material.

EAVES SOFFIT: The underside of "T" Deck presents a corrugated or trough appearance. If the overhang at verge or eaves requires a flush soffit this can be obtained with the use of Atlas Soffit Panels secured to the underside of the deck with self-tapping screws, Rawlnuts or other types of blind fixings. The wood blocks that provide fixing grounds for the fascia board should be set in the depth of the trough section and not rest on the eaves soffit board.

VERGES: In the verge Detail No. 13 the units run parallel to the overhang and the wood fascia and metal flashing are screwed to wood strips fixed in the depth of the cavity. The maximum unsupported overhang is 7½" i.e., not more than half the cover width, and is carefully set out so that the corrugated section will provide the fullest strength to the cantilever.

PARAPET WALLS: Where the deck runs parallel to a parapet wall, precaution must be taken to ensure that the side edges of the deck are adequately supported. This can be done by introducing a continuous wood fillet or fixing block in the depth of the cavity to which units may be screwed top and bottom. (Detail No. 6).

Alternatively, a shelf angle having a bearing of 2" should be included. This edge support must be introduced when purlin spacing exceeds 5'0". Where the deck runs at right angles to the parapet it may be "built in".

MONITOR CURBS: At Monitor and Rooflight openings suitable steel or concrete trimmers are required to support the "T" Deck. A suggested detail for a concrete curb and a detail for a timber curb on steel construction is shown in Details Nos. 7 and 8.

EXPANSION JOINTS: It will not be found necessary to make provision for expansion parallel to the direction of the units because this will be taken care of by the usual working clearance at the end butt joints.

For expansion across the units, however, provision can be made as shown. Such an expansion joint treatment will normally only be required where provided for in the structural frame of the building (Detail No. 9). Approximately 200 ft. c/c.

CEILING FINISH: "T" Deck provides a regular, troughed, smooth surfaced soffit which is normally left as laid.

OTHER CEILING FINISHES: The Decking is extremely adaptable to the use of a suspended ceiling of many varieties. Metal hangers may be attached for use in conjunction with special systems of suspended ceilings. (Detail No. 10).

PREPARATION FOR BUILT-UP ROOFING.

WITH INSULATION: Standard built-up roofing can be applied over conventional rigid insulation laid **directly** on the deck in accordance with respective manufacturer's instructions. The external surface texture of "T" Deck provides a friction bond for insulation boards or key for adhesives with vapour barrier.

On steep slopes, if required, a mechanical key can be provided by screwed battens. See Detail No. 11

WITHOUT INSULATION: If drainage slopes are provided with cement and sand screed, then lay built-up roofing as for concrete surface. If the built-up roofing is applied directly to the deck, and a flat overall surface is required, the shallow joint grooves may be filled with a PVC plastic extrusion, (available from J. E. Goodman Sales Limited, 760 Avenue Halpern, Dorval, Que. 514-631-4524); or with mortar of good adhesion. Normal mortar should contain fine soft building sand and Portland cement at 1:1 ratio.

In hot weather dampen the grooves to avoid rapid drying out before initial set has taken place. For temperatures below 32°F. but not lower than 15°F. a non-freeze compounded mortar should be used without the addition of sand or water. A suitable "No-Freeze" Fluid is obtainable from A. C. Horn & Co. Limited.

If the finished roof surface is to be used for traffic (sun-decks, roof gardens, maintenance, etc.,) install Atlas Promenade Tiles over the built-up roofing. Information is contained in Atlas Form AA3243 available on request.

DRAINAGE SLOPES: Drainage slopes can best be provided by adjusting the levels of the sub-structure to suit, but if this is impractical, a light weight concrete fill may be applied over the roof deck, in which case the shallow groove at the joints will assist in forming a key.

ELECTRIC WIRING AND SERVICES: The cavities may be conveniently used for raceways, housing electric conduits or other services providing they can be arranged to run parallel with the length of the units. (Detail No. 12).

PIPES: Small openings up to 6" Dia. for Flue, Soil, Vent and Rain-water pipes can be accommodated provided these penetrate the decking clear of the joint. Large openings will always need trimmings as with any other form of decking (see Detail No. 13).

HUNG LOADS: Suspend services or equipment as Detail No. 10A and check with Atlas Asbestos Company regarding maximum loads. Very heavy loads require their own separate supports.

CUSTOMER ERECTION: To secure satisfactory application, work must be carefully planned. Before starting the job check the material and decide how it is to be used. Although "T" Deck supplied is of excellent quality the finished job may be greatly impaired by faulty application or improper attention to details.

Contact your Branch of Atlas Asbestos Company for assistance.

STORAGE: Preferably, the units should be stacked on end with the top leaning against a wall or other suitable support. This will relieve the weight, avoid strain or the need for packing pieces and economize in storage space. Nest the corrugations neatly and rope together to avoid wind damage. Fig. 3.

REPLACEMENT OF UNITS: Should it become necessary to remove and/or replace one of the units in the middle of an area of decking, the following procedure can be adopted:

Take out the line of screws **in the overlapping** member of the unit to be removed together with the screws **on the next two** overlapping units. Remove cement grout from grooves. It will then be found quite practicable to slide out the unit intact.

To effect the replacement it will be necessary to insert small wedges between the supports and the bottom of the overlapping unit adjoining the replacement when with limited manipulation the corrugated part of the new unit can be worked under the overlapping flat and slid into its correct position.

Alternate method of damaged sheet replacement:

1. Strip roofing and insulation if any at a width of 30" (two overlapping width x sheet length).
2. Cut out overlapping sheets.
3. Cut out underlapping corrugated portion of sheets.
4. Replace all with new equal size pieces.
5. Replace insulation and roofing, if any.

Self-tapping screws should be used for refixing both under and overlaps. If a new unit is inserted use the old one as a template in hole drilling.

CRATING: Carload and truckload shipments of "T" Deck are shipped uncrated. Less than carload and truckload lots are shipped crated with a nominal crating charge. Fasteners are shipped in bags and cartons. Fig. 4.

TABLE 3 MATERIAL QUANTITIES PER 100 SQ. FT. OF "T" DECK.

LENGTH OF UNIT IN FEET	No. OF UNITS	FIXINGS			
		SCREWS OR SETS OF NUTS, BOLT, CLIPS TO SECURE DECK TO BEARERS			ASSEMBLY SELF-TAPPING SCREWS
		FLAT→10° SLOPE	10°→20°	20° AND UP	
4	14.3	10	15	29	72
5	11.4	8	13	23	57
6	9.5	7	10	19	48
7	8.6	6	9	17	43
8	7.1	5	8	15	36

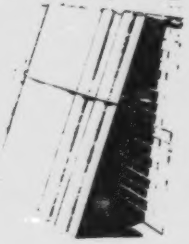
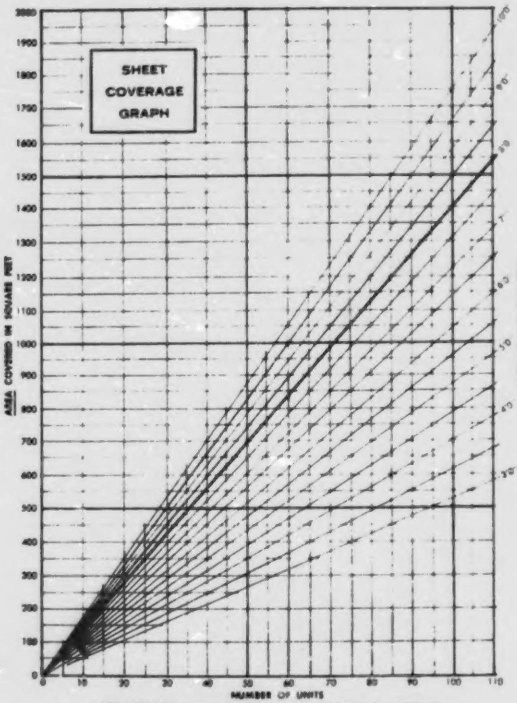
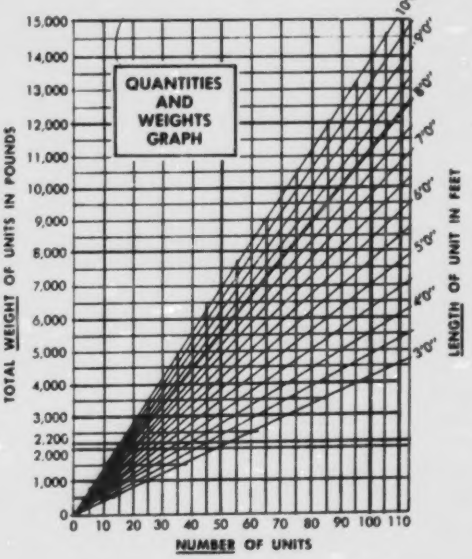


FIG. 3 STACKING



FOR LARGER OR SMALLER NUMBERS MULTIPLY OR DIVIDE BY FACTOR 10

FIG. 2



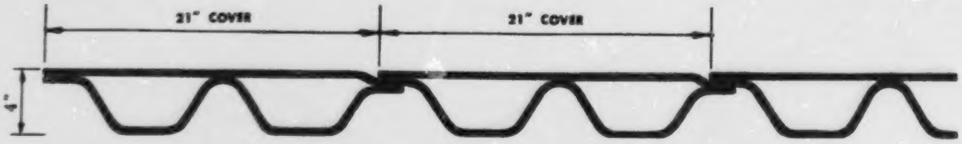
FOR LARGER OR SMALLER NUMBERS MULTIPLY OR DIVIDE BY FACTOR 10

FIG. 4

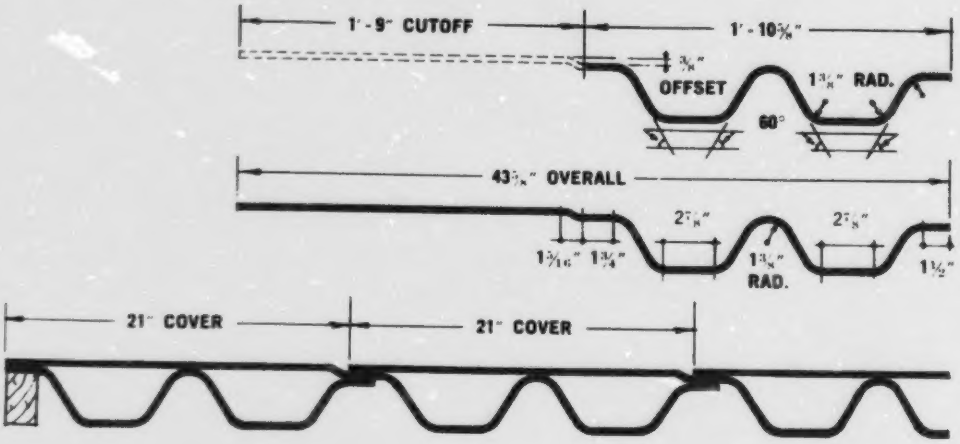
EXAMPLE: What are the nominal material quantities required for 56,000 sq. ft. of "T" Deck, using 7'0" Span on 15° slope.

No. of "T" Deck Units = (56,000: 100) x 8.6 = 4,816
No. of Fixings = (56,000: 100) x 9 = 5,040
No. of Screws = (56,000: 100) x 43 = 24,010

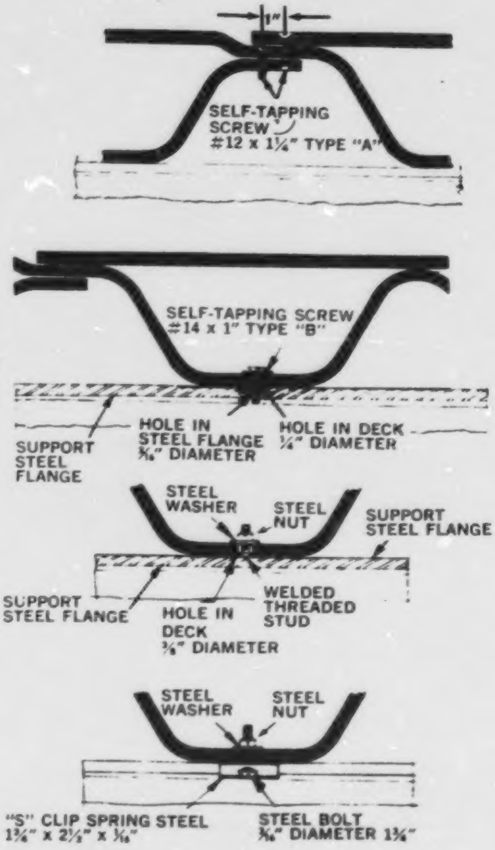
DETAIL 1 SECTION THROUGH DECK AS LAID. SCALE: 1½" = 1'10"



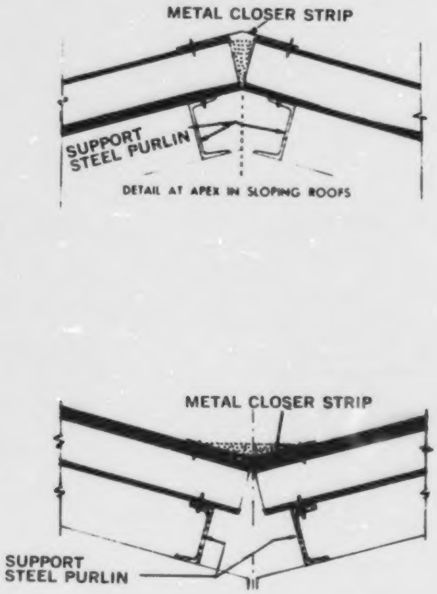
DETAIL 2 STARTING THE ROOF



DETAIL 3 ASSEMBLY FIXINGS



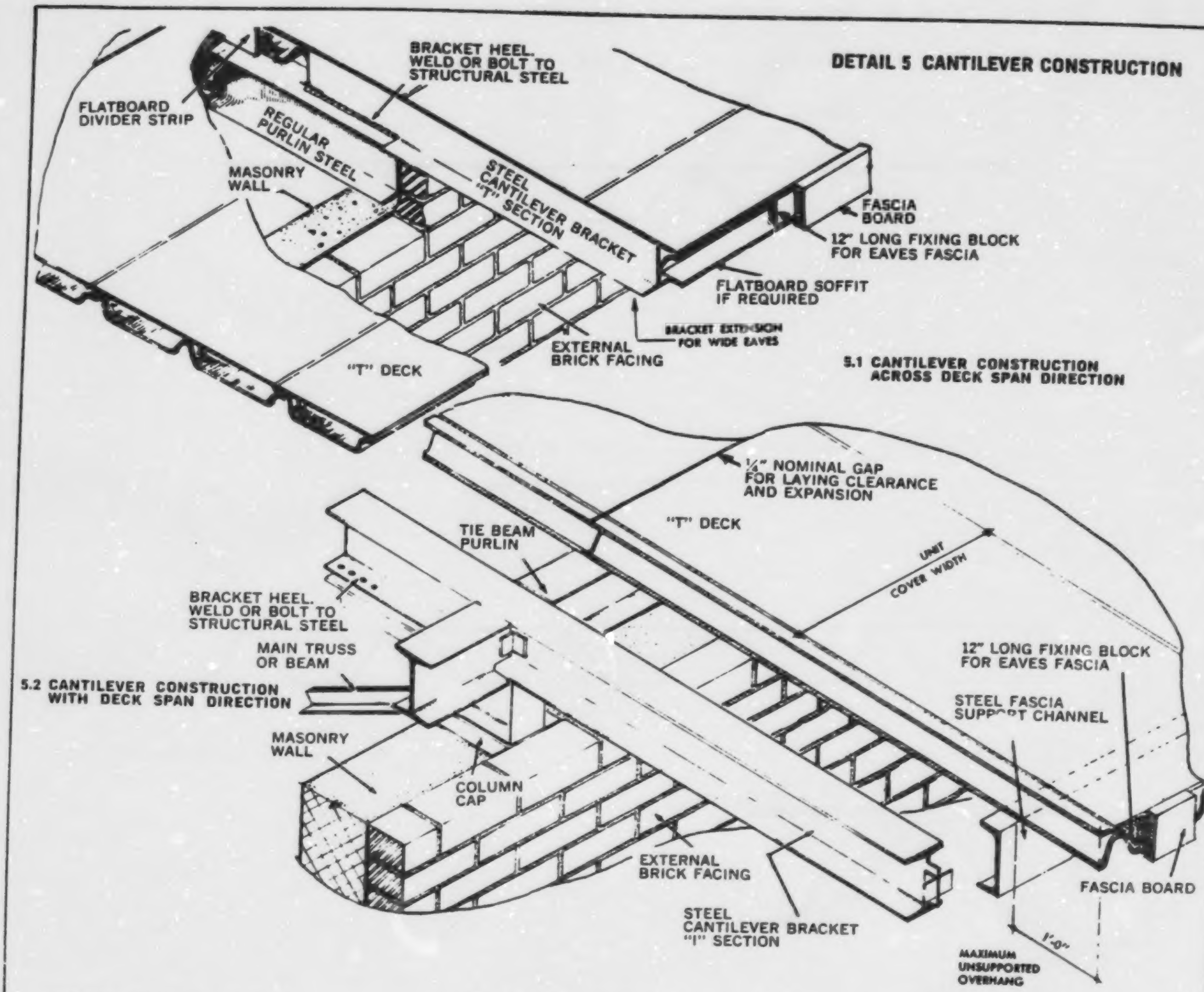
DETAIL 4 APEX AND VALLEY DETAIL



ATLAS ASBESTOS COMPANY
PRODUCT: ATLAS "T" DECK

DATE: MARCH 1970	TYPICAL APPLICATION DETAILS STARTING DECK, FIXINGS, APEX VALLEY	DRAWING NUMBER: I
SCALE: NOT TO SCALE		

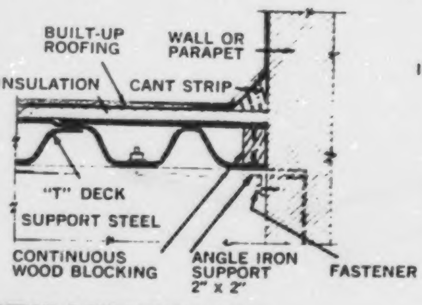
DETAIL 5 CANTILEVER CONSTRUCTION


BRACKET HEEL. WELD OR BOLT TO STRUCTURAL STEEL
FLATBOARD DIVIDER STRIP
REGULAR PURLIN STEEL
MASONRY WALL
STEEL CANTILEVER BRACKET "T" SECTION
FASCIA BOARD
12" LONG FIXING BLOCK FOR EAVES FASCIA
FLATBOARD SOFFIT IF REQUIRED
BRACKET EXTENSION FOR WIDE EAVES
EXTERNAL BRICK FACING
"T" DECK
¼" NOMINAL GAP FOR LAYING CLEARANCE AND EXPANSION
"T" DECK
UNIT COVER WIDTH
TIE BEAM PURLIN
BRACKET HEEL. WELD OR BOLT TO STRUCTURAL STEEL
MAIN TRUSS OR BEAM
MASONRY WALL
COLUMN CAP
12" LONG FIXING BLOCK FOR EAVES FASCIA
STEEL FASCIA SUPPORT CHANNEL
EXTERNAL BRICK FACING
STEEL CANTILEVER BRACKET "I" SECTION
FASCIA BOARD
1'-0"
MAXIMUM UNSUPPORTED OVERHANG

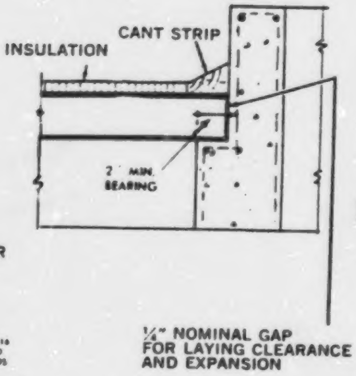
5.1 CANTILEVER CONSTRUCTION ACROSS DECK SPAN DIRECTION

5.2 CANTILEVER CONSTRUCTION WITH DECK SPAN DIRECTION

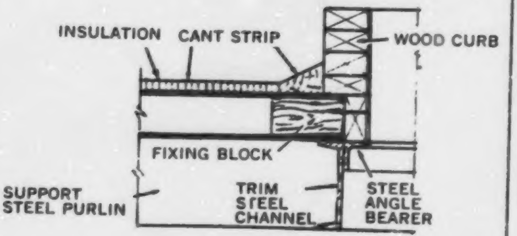
DETAIL 6 PARAPET WALLS



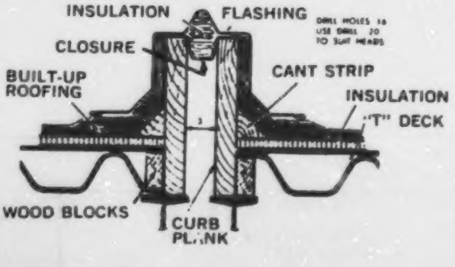
DETAIL 7 CONCRETE CURB



DETAIL 8 TIMBER CURB



DETAIL 9 EXPANSION JOINTS



ATLAS ASBESTOS COMPANY
PRODUCT: ATLAS "T" DECK

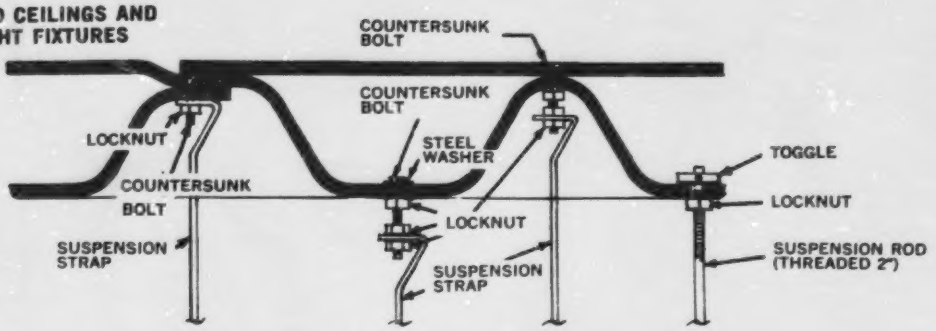
DATE: MARCH 1970
SCALE: NOT TO SCALE

TYPICAL APPLICATION DETAILS
CANTILEVER CONSTRUCTION, PARAPET WALLS, CURBS

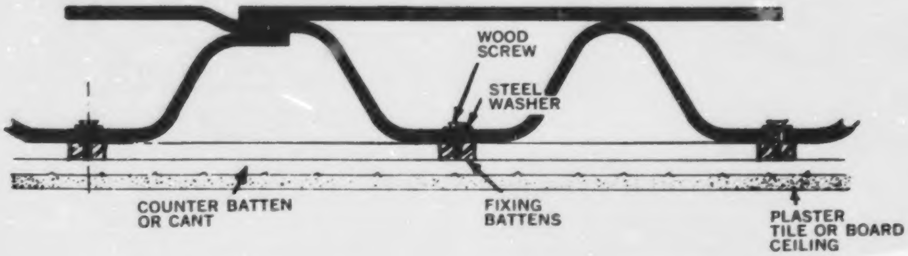
DRAWING NUMBER: 2

DETAIL 10 OTHER CEILING FINISHES

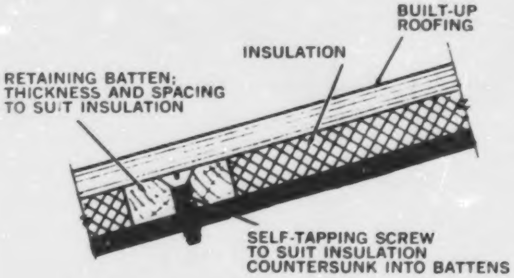
A. SUSPENDED CEILINGS AND LIGHTWEIGHT FIXTURES



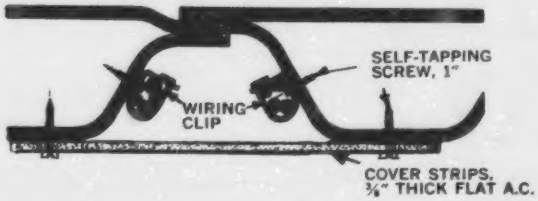
B. CEILING ON BATTENS



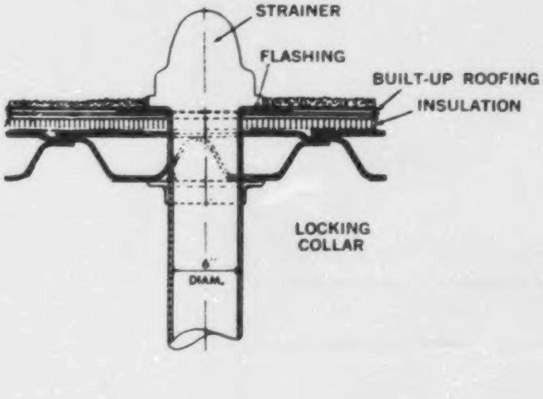
DETAIL 11 INSULATION ON STEEP ROOF SLOPES


BUILT-UP ROOFING
INSULATION
RETAINING BATTEN; THICKNESS AND SPACING TO SUIT INSULATION
SELF-TAPPING SCREW TO SUIT INSULATION COUNTERSUNK INTO BATTENS

DETAIL 12 ELECTRIC WIRING AND OTHER SERVICES



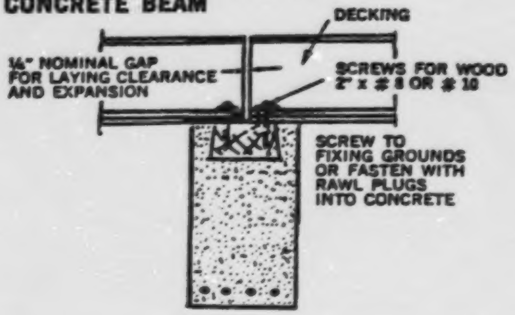
DETAIL 13 OPENINGS



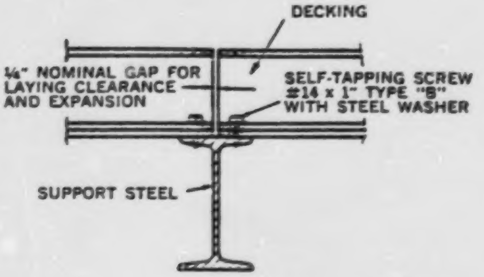
ATLAS ASBESTOS COMPANY
PRODUCT: ATLAS "T" DECK

DATE: MARCH 1970	TYPICAL DETAIL DRAWINGS	DRAWING NUMBER:
SCALE: NOT TO SCALE	CEILING FINISHES, ROOF SLOPES, DRAINS, TABLE TRAYS	3

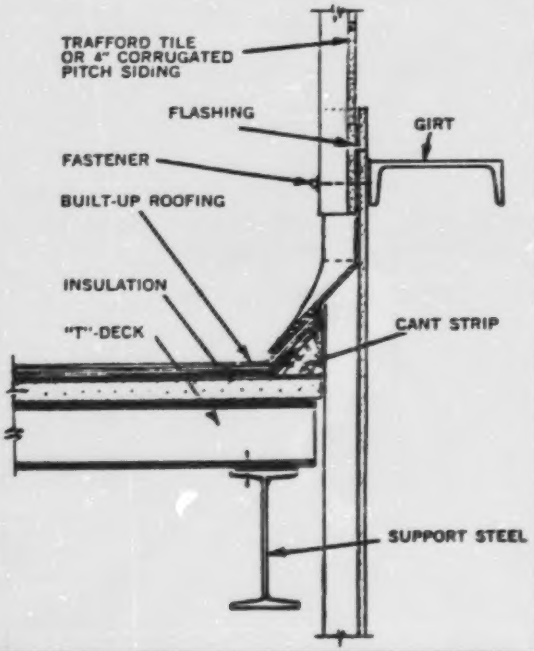
ATTACHMENT TO REINFORCED CONCRETE BEAM


DECKING
¼" NOMINAL GAP FOR LAYING CLEARANCE AND EXPANSION
SCREWS FOR WOOD 2" x # 8 OR # 10
SCREW TO FIXING GROUNDS OR FASTEN WITH RAWL PLUGS INTO CONCRETE

ATTACHMENT TO STRUCTURAL STEEL BEAM

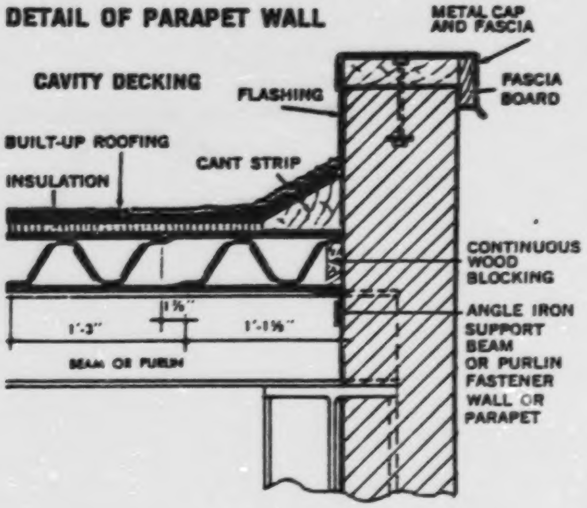

DECKING
¼" NOMINAL GAP FOR LAYING CLEARANCE AND EXPANSION
SELF-TAPPING SCREW #14 x 1" TYPE "B" WITH STEEL WASHER
SUPPORT STEEL

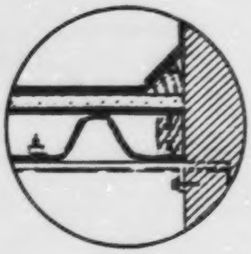
JUNCTION TO STRUCTURE — SIDING



CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

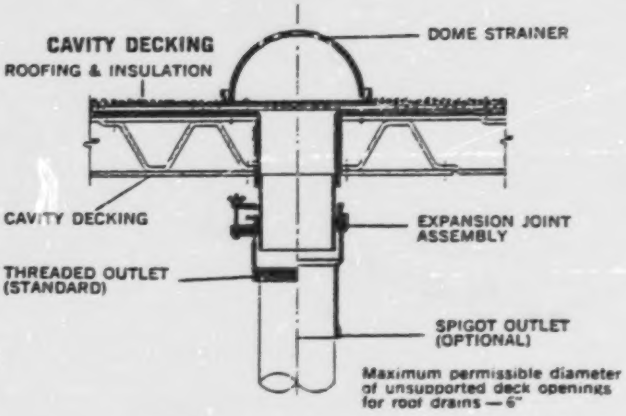
DETAIL OF PARAPET WALL



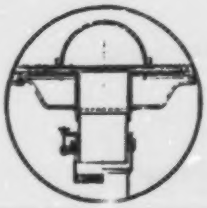


"T" DECK

ROOF DRAIN AND PIPE OPENING



Maximum permissible diameter of unsupported deck openings for roof drains — 6"



"T" DECK

ATLAS TURNER INC.
PRODUCT: CAVITY DECKING AND T-DECK

DATE: JAN. 1970	TYPICAL DETAILS:	DRAWING NUMBER:
SCALE: NOT TO SCALE	FLAT ROOFS	D1

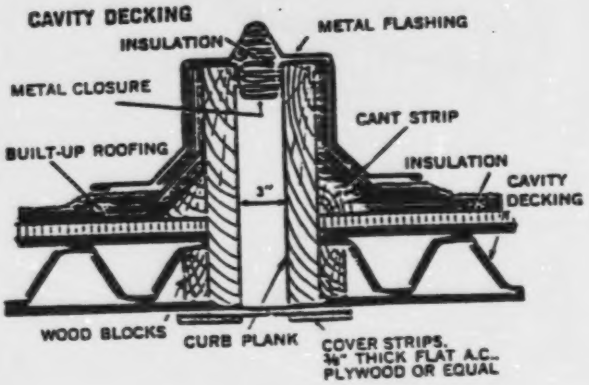
FORM A.T. 7-3354 /1

ATLAS TURNER

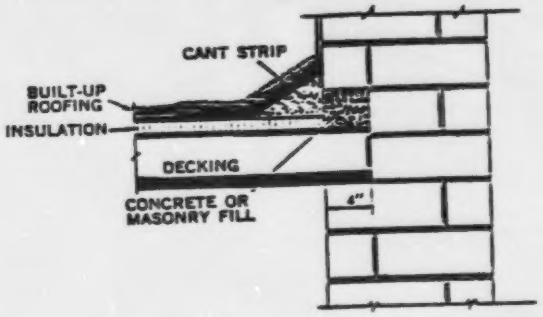
Atlas Turner Inc.
October 1980
(Supersedes Sept. 1973)

3P CEMENTITIOUS DECKS

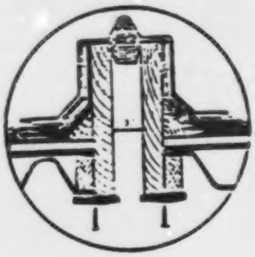
EXPANSION JOINTS



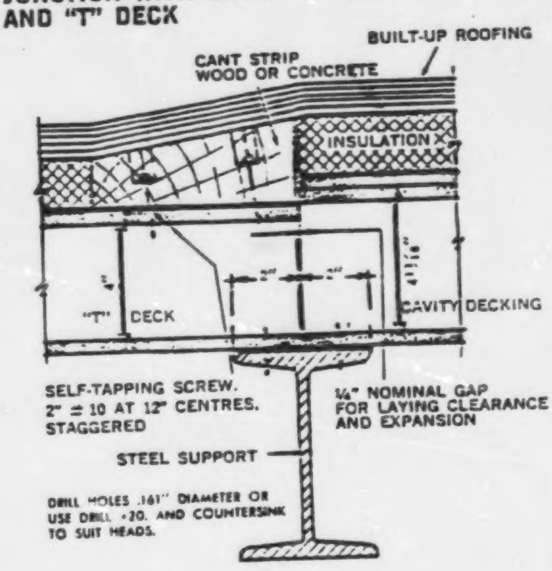
JUNCTION WALL — DECK BUILT IN



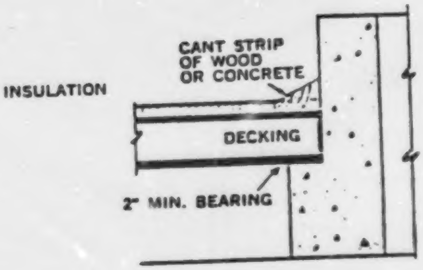
"T" DECK



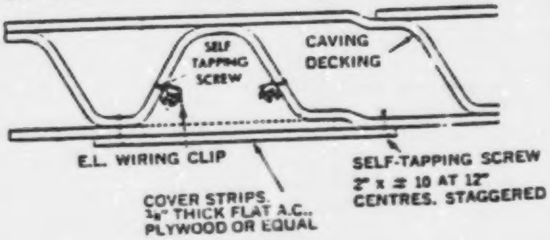
JUNCTION WITH CAVITY DECKING AND "T" DECK


BUILT-UP ROOFING
CANT STRIP WOOD OR CONCRETE
INSULATION
2"
2"
"T" DECK
CAVITY DECKING
SELF-TAPPING SCREW. 2" ≠ 10 AT 12" CENTRES, STAGGERED
¼" NOMINAL GAP FOR LAYING CLEARANCE AND EXPANSION
STEEL SUPPORT
DRILL HOLES .161" DIAMETER OR USE DRILL ≠20, AND COUNTERSINK TO SUIT HEADS.

SHELF BEARING



CONCEALED ELECTRICAL WIRING

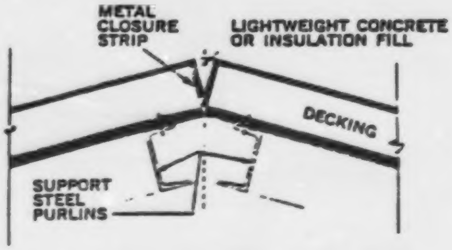

SELF TAPPING SCREW
CAVING DECKING
E.L. WIRING CLIP
SELF-TAPPING SCREW 2" x ≠ 10 AT 12" CENTRES, STAGGERED
COVER STRIPS, ¾" THICK FLAT A.C., PLYWOOD OR EQUAL

CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

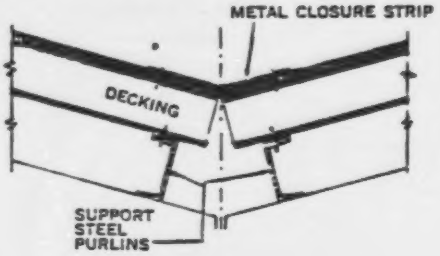
ATLAS TURNER INC.
PRODUCT: CAVITY DECKING AND T-DECK

DATE: JAN. 1970	TYPICAL DETAILS: FLAT ROOFS	DRAWING NUMBER: D 2
SCALE: NOT TO SCALE		

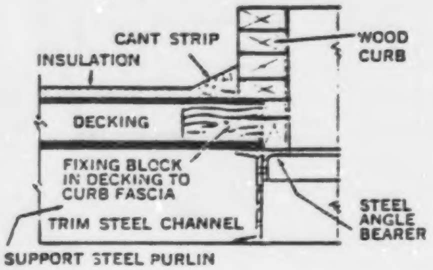
ROOF APEX



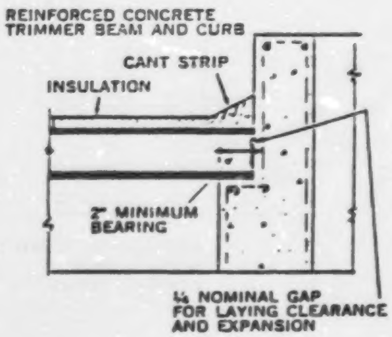
ROOF VALLEY



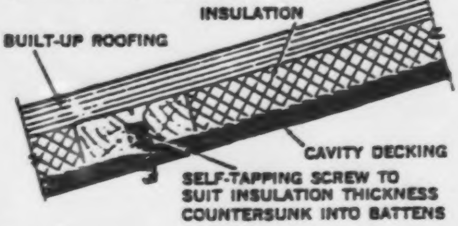
SKYLIGHT OR ROOF OPENING
STEEL TRIMMER AND TIMBER CURB



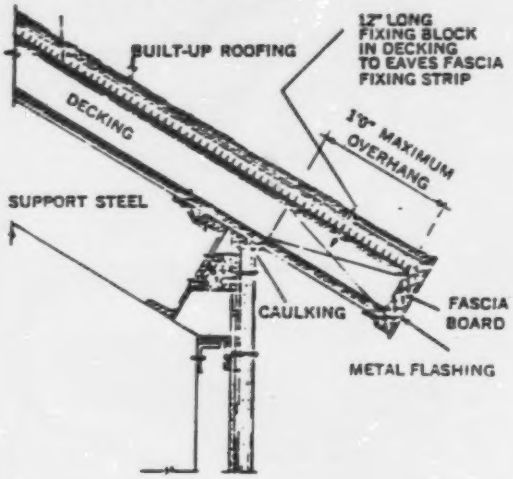
SKYLIGHT OR ROOF OPENING


REINFORCED CONCRETE TRIMMER BEAM AND CURB
CANT STRIP
INSULATION
2" MINIMUM BEARING
¼ NOMINAL GAP FOR LAYING CLEARANCE AND EXPANSION

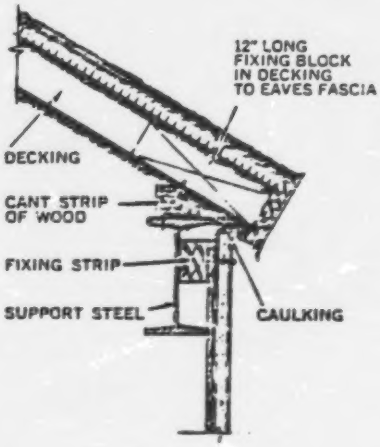
INSULATION RETAINER STRIP


INSULATION
BUILT-UP ROOFING
CAVITY DECKING
SELF-TAPPING SCREW TO SUIT INSULATION THICKNESS COUNTERSUNK INTO BATTENS

EAVE WITH OVERHANG



EAVE WITH NO OVERHANG

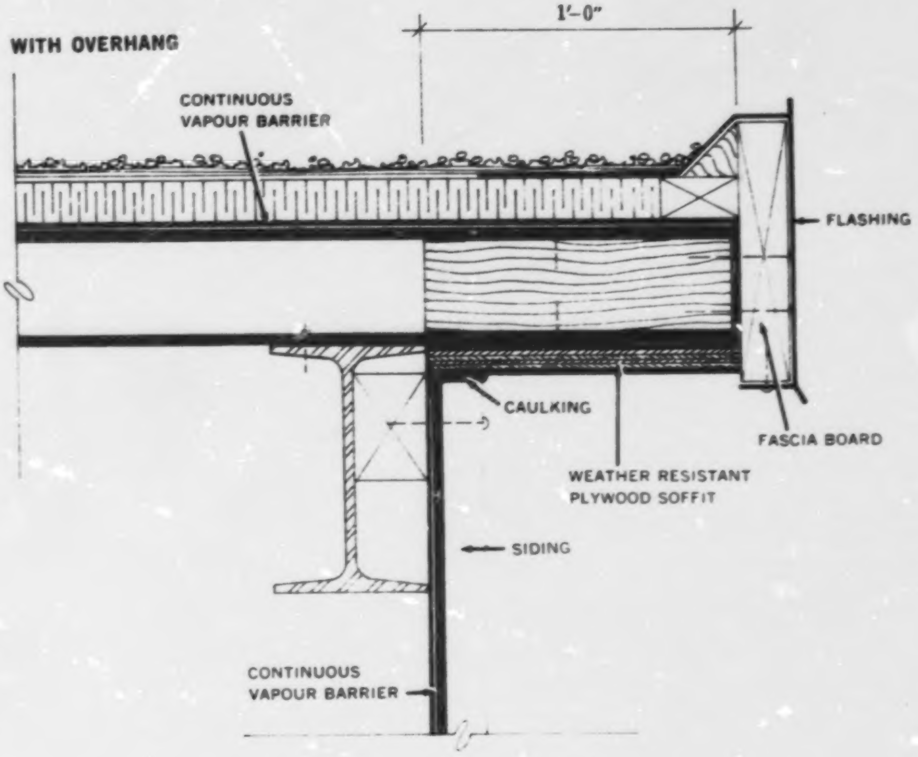


CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

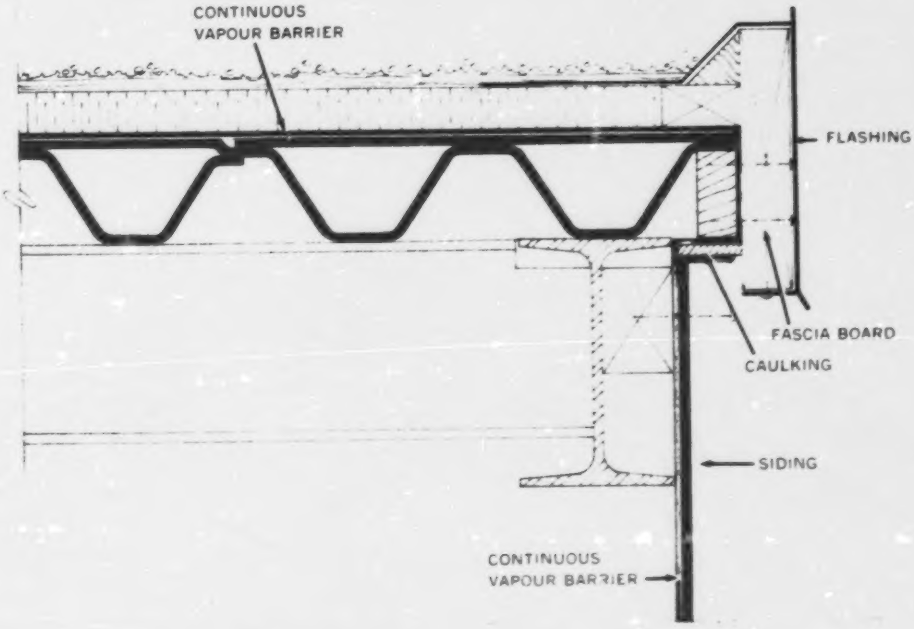
ATLAS TURNER INC.
PRODUCT: CAVITY DECKING AND T-DECK

DATE: JAN. 1970	TYPICAL DETAILS:	DRAWING NUMBER:
SCALE: NOT TO SCALE	SLOPING ROOFS AND ROOF OPENINGS	D 3

WITH OVERHANG


1'-0"
CONTINUOUS VAPOUR BARRIER
FLASHING
CAULKING
FASCIA BOARD
WEATHER RESISTANT PLYWOOD SOFFIT
SIDING
CONTINUOUS VAPOUR BARRIER

NO OVERHANG



ATLAS TURNER

Atlas Turner Inc
October 1980
(Supersedes Sept 1973)

3P CEMENTITIOUS DECKS

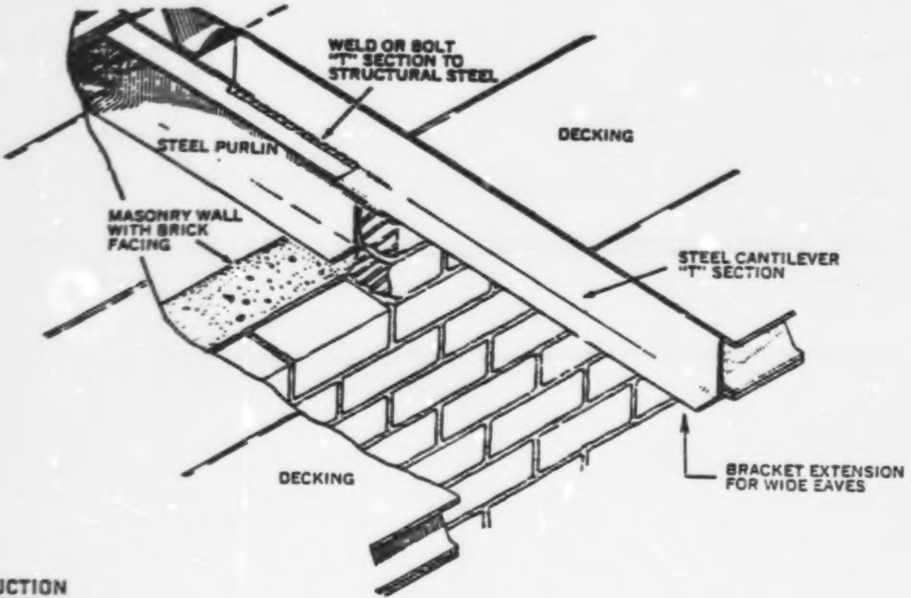
CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

ATLAS TURNER INC.
PRODUCT: CAVITY DECKING AND "T" DECK

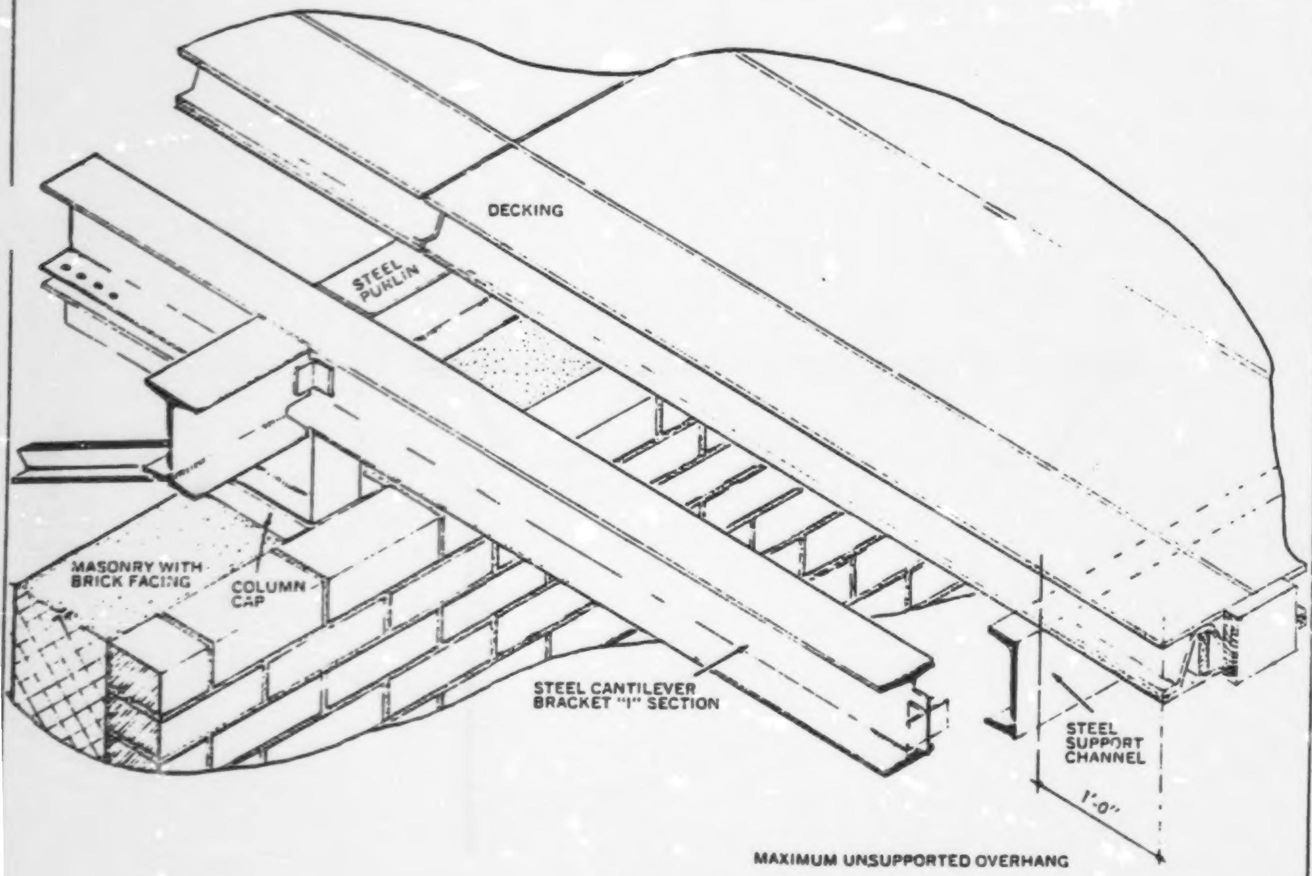
DATE APRIL 1970	TYPICAL DETAILS EAVES SECTIONS	DRAWING NUMBER D 4
SCALE NOT TO SCALE		

Printed in Canada

CANTILEVER CONSTRUCTION ACROSS DECK SPAN DIRECTION


WELD OR BOLT "T" SECTION TO STRUCTURAL STEEL
DECKING
STEEL PURLIN
MASONRY WALL WITH BRICK FACING
STEEL CANTILEVER "T" SECTION
DECKING
BRACKET EXTENSION FOR WIDE EAVES

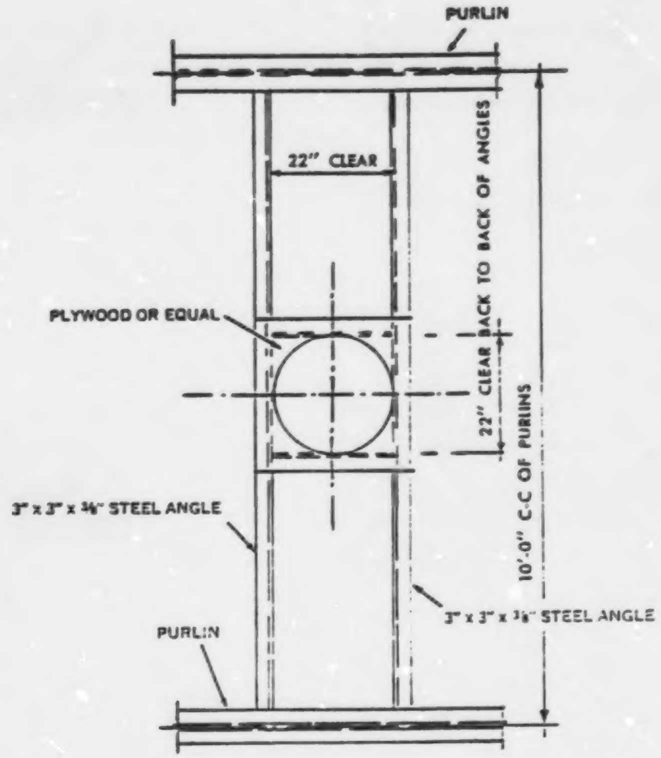
CANTILEVER CONSTRUCTION WITH DECK SPAN DIRECTION


DECKING
STEEL PURLIN
MASONRY WITH BRICK FACING
COLUMN CAP
STEEL CANTILEVER BRACKET "I" SECTION
STEEL SUPPORT CHANNEL
1'-0"
MAXIMUM UNSUPPORTED OVERHANG

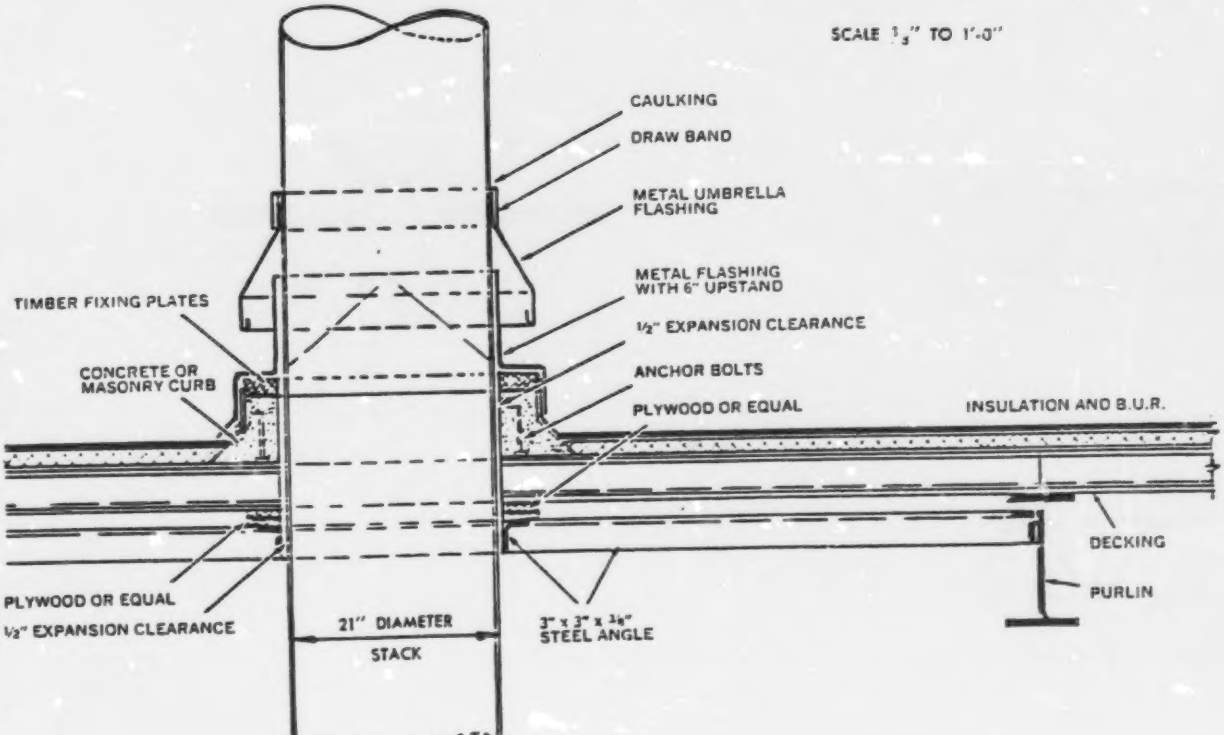
CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

ATLAS TURNER INC.
PRODUCT: CAVITY DECKING AND T-DECK

DATE: JAN. 1970	TYPICAL DETAILS:	DRAWING NUMBER:
SCALE: NOT TO SCALE	WIDE EAVES CONSTRUCTION	D 5


PURLIN
22" CLEAR
22" CLEAR BACK TO BACK OF ANGLES
PLYWOOD OR EQUAL
10'-0" C-C OF PURLINS
3" x 3" x 3/8" STEEL ANGLE
3" x 3" x 3/8" STEEL ANGLE
PURLIN

SCALE ½" TO 1'-0"

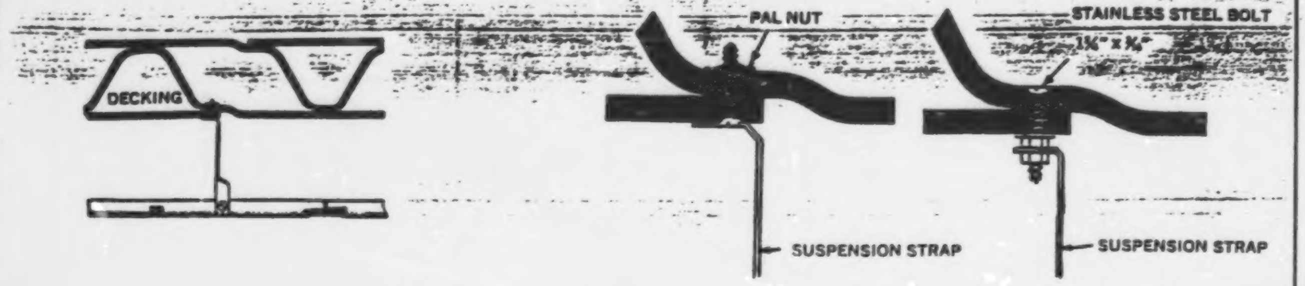


SCALE ¾" TO 1'-0"

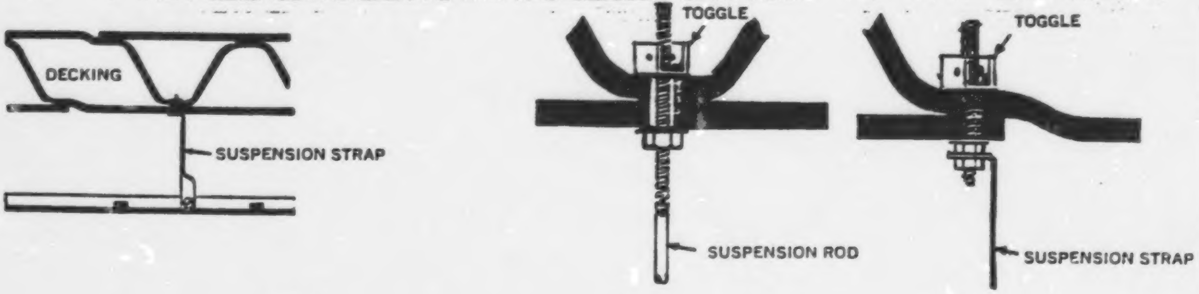
CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

ATLAS TURNER INC.
PRODUCT. CAVITY DECKING AND T-DECK

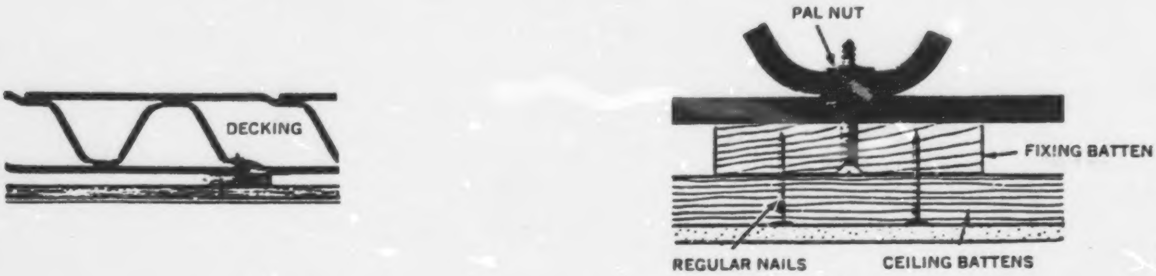
DATE: JAN. 1970	TYPICAL DETAILS:	DRAWING NUMBER:
SCALE: AS NOTED	HOLES IN DECK FOR FLUE STACKS	D 6



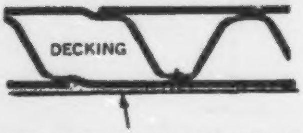
NOTE: SUSPENSION STRAPS TO BE FIXED THROUGH DOUBLE THICKNESS OF ASBESTOS-CEMENT



NOTE: DETAIL OF METAL SUSPENSION SYSTEM FOR FLAT CEILING OR ACOUSTIC PANELS AND/OR FIXTURES



NOTE: DETAIL OF WOOD SUSPENSION SYSTEM FOR FLAT CEILING OR ACOUSTIC PANELS



INSULATION FINISH UP TO 2" THICK

CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

ATLAS TURNER INC.
PRODUCT: CAVITY DECKING AND T-DECK

DATE: SEPT. 1973	TYPICAL DETAILS: CEILING OR LIGHTWEIGHT FIXTURE SUSPENSION	DRAWING NUMBER: D 7
SCALE: NOT TO SCALE		

ATLAS TURNER

Atlas Turner Inc.
October 1980
(Supersedes Sept. 1973)

3p CEMENTITIOUS DECKS

SPECIFICATION GUIDE

CAVITY ROOF DECKING FOR DRY KILNS

1. SCOPE OF WORK

Supply and complete installation of Cavity Roof Decking as shown or called for on architectural and structural drawings and as specified herein.

2. Materials

2.1 The decking shall be Cavity Roof Decking as manufactured by Atlas Turner Inc. designed to carry a minimum 40-lb/sq.ft. live load at a maximum span of 10-ft. with a minimum end bearing of 2".

2.2 Seal all underlaps of Cavity Roof Decking with a non-hardening moisture resistant sealing compound such as .... or equal. (Note 1)

2.3 Install a wall vapour barrier of 15-lb. roofing felt with 1/8" mastic on both sides, such as .... or equal. (Note 2)

2.4 Protect surfaces of steel girders and beams with a 15-lb. asphalt roofing felt having 1/8" mastic on both sides such as .... or equal. (Note 2)

2.5 Apply a 3/8" coat of black plastic cement over structural steel and concrete surfaces coming in contact with Cavity Roof Decking.

2.6 Treat all wood blocking with a creosoting solution such as .... manufactured by .... or equal.(Note 3)

2.7 Insulation material shall be .... thickness of .... and manufactured by .... or equal. (note 5)

3. Application

3.1 Cavity Roof Decking: Fix decking to steel purlins with No. 14 x 1" Hex Head stainless steel self-tapping screws and steel washer, one at each end of every third unit.

3.2 Assembly Fixings: for OVERLAP use No. 12 x 1¼" flat head self-tapping stainless steel bolts with stainless steel palnuts, 1' 6" from at 2'4" O.C.; for UNDERLAP use 3/16" x 1¼" stainless steel bolts with stainless steel palnut washers, 1'6" from either end and on the bottom lap and at no more than 1'9" O.C.(Note 4)

Note 1: Specify brand name and manufacturer. We recommend the use of sealants manufactured by the Tremco organization or equal.

Note 2: Specify brand name and manufacturer. We recommend the use of mastics manufactured by the Flintkote organization or equal.

Note 3: Specify brand name and manufacturer. We recommend the use of a creosoting solution manufactured by the Domtar organization or equal.

Note 4: Atlas Turner Inc. has issued complete application instructions regarding Cavity Roof Decking (No. AT4501/B), which are available, upon request, from Sales Service.

CAUTION: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

3.3 Joint Sealant. Seal all lateral underlap joints with a 1/2" x 3/16" sealing tape or T bead of the non-hardening, non-staining type, such as .... or equal, placed along its edge. (Note 1)

3.4 Vapour & Moisture Protection: The wall vapour barrier, shall consist of a continuous coating of 15-lb. asphalt saturated roofing felt in a minimum coat of 1/8" mastic on both sides. Cavity Roof Decking units must be embedded in a 3/8" coat of black plastic cement applied prior to the installation of the sheets. Insulation material shall be of the type and thickness suitable for kiln conditions to maintain interior temperature and relative humidity at the acceptable level to prevent surface condensation from occuring. (Note 6)

3.5 Manufacturers' Instructions: The application of Cavity Roof Decking and its components as outlined in this specification shall be carried out in accordance with manufacturers' instructions. (Note 5)

Note 5: Kiln design engineer to determine insulation requirements to suit specific interior conditions.

Note 6: Atlas Cavity Deck is cementitious in nature and subject to corrosion under acidic atmosphere. Proper precautions shall be exercised to prevent interior surface condensation.

Note 7: We recommend that Applicators refer to published manufacturers' instructions regarding all other specified decking components.

4. GUARANTEE:

4.1 Atlas Turner Inc, warrants Cavity Roof Decking to be free from defects in material and workmanship for a period not exceeding one year from date of shipment. The Company's obligation under this warranty is limited to the purchase price of defective material and does not extend to the assumption of any other liability, direct or indirect, or consequential damages of any nature whatsoever. Atlas Turner Inc, makes no other warranty express or implied with respect to Cavity Roof Decking and no person is authorized to bind the Company by any further warranty whatsoever.

4.2 Contractors are normally required to deliver to the architect, after installation and before final acceptance, a written warranty stating that the installation will remain free of defects for a period not exceeding 12 months following the date on which the installation was completed.

4.3 Damaged or defective material installed, reported during warranty period, shall be removed and replaced with undamaged material by the sub-contractor without cost to the general contractor and/or owner.

ATLAS TURNER INC

MONTREAL •
TORONTO •
WINNIPEG •
EDMONTON •
VANCOUVER •

DISTRICT SALES OFFICES:
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U.S.A. FACTORY REPRESENTATIVES:
Andy Richardson, P.O. Box 1742, Lancaster, PA. 17604/(717)569-3821
Donald R. Stevenson, P.O. Box 3278, Langley, B.C. V3A 4R6/(604) 530-0143/
Telex: 04-365535
L. Robert Enslin Jr., 3320 Holliglen Drive, Marietta G.A. 30062/(404) 977-9033

SPECIFICATION GUIDE

ATLAS ASBESTOS FIBER REINFORCED CEMENT CAVITY ROOF DECKING

1. GENERAL

1.1 GENERAL CONDITIONS:

1.1.1 The general conditions of the standard contract for the construction of buildings, latest revised edition and supplementary general conditions shall govern this work.

1.1.2 Workmanship, method of installation, materials, flashings, trim and accessories shall conform to manufacturers' current recommendations.

1.2 SCOPE:

1.2.1 Work included: Supply and complete installation of Cavity Roof Decking as shown or called for on architectural and structural drawings and as specified herein. (Note 1).

1.2.2 Work excluded: Supporting frame (describe). Installation of materials under other Divisions.

1.3 EXAMINATIONS:

1.3.1 Check site dimensions.

1.3.2 Examine other work upon which this work depends.

1.3.3 Examine all structural framing and supporting structure. Install only after structural defects are corrected, all permanent connections are completed and supporting structure has been made plumb.

1.4 SHOP DRAWINGS:

1.4.1 Use manufacturer's typical detail drawings as guide in making shop drawings. Use in conjunction with working drawing # ....

1.4.2 Shop drawings are not required. (Note 2).

1.5 INSPECTION AND TESTING:

1.5.1 (Architect, resident inspector, owner) will inspect work during and after installation. (Note 3).

1.5.2 Manufacturer or approved representative will inspect the completed installation (before handing over). (Note 4).

1.6 STANDARDS:

NOTES TO SPECIFIER:

1. Product Data Sheets, Specification Guides, Typical Detail Drawing Sheets and Standard Application Instructions are available without charge. State number of copies required for project. Contact nearest Atlas Office or Representative or Atlas Turner Inc. Specification Service, 5600 Hochelaga, Montreal, Que. H1N 1W1 (514)259-2531.

2. Delete non-applicable clause.

3. State who shall carry out inspection.

4. Delete bracketted clause if not applicable.

Atlas Turner Inc.
March 1980
(Supersedes September 1973)

3p CEMENTITIOUS DECKS

Caution: These products contain asbestos. Use recommended work practices when working and handling. Copies of work practices are available from suppliers.

1.6.1 Hazard Classification (Fire); ASTM E84-UL Label:Flame Spread 0; Fuel Contributed 0; Smoke Developed 0,

1.6.2 Factory Mutual: Cavity Roof Decking is classified as a non-combustible deck not requiring sprinkler protection. Cavity Roof Decking exceeds the 60 psf. min. Factory Mutual requirement for adequate wind uplift resistance.

1.7 SAMPLES:

1.7.1 Submit samples of material for approval of architect and/or general contractor prior to commencement of work. Approved samples constitute examples of minimum workmanship to be expected for all exposed installations of material.

1.7.2 Samples are not required. (Note 2).

1.8 DELIVERY, HANDLING AND STORAGE:

1.8.1 Accept only material bearing the name of the manufacturer and the brand.

1.8.2 Reject any sheets damaged in transit.

1.8.3 Prevent damage to materials during handling, storage and application. Guard against impact and abrasion.

1.8.4 Stack sheets on end, clear of ground, leaning against a firm support and evenly nested.

1.8.5 Store packaged materials in original undamaged condition with manufacturers' labels and seals intact.

1.9 PROTECTION:

1.9.1 Protect work from damage by scaffolding.

1.9.2 Protect work of other Divisions associated with or adjacent to the work of this Division.

1.9.3 Keep work clean and free from any injurious or disfiguring material.

1.9.4 Make good any damage or soiled work to satisfaction of architect.

1.10 CLEAN UP:

Remove debris and surplus material as installation work proceeds and upon its completion. (Note 5).

5. If required, to remove daily or at specified times, state cleaning interval.

1.11 WARRANTY:

1.11.1 After installation and before final acceptance by the architect, the sub-contractor shall deliver to the architect a written warranty stating that the installation will remain free of defects for a period not exceeding 12 months following the date on which the installation was completed.

1.11.2 Damaged or defective material installed, reported during warranty period, shall be removed and replaced with undamaged material by the sub-contractor without cost to general contractor and/or owner.

2. MATERIALS AND APPLICATION:

2.1 MATERIALS:

2.1.1 All roof decking specified herein and called for on architectural and structural drawings shall be Atlas asbestos fiber reinforced cement Cavity Roof Decking as manufactured by Atlas Turner Inc., Montreal, Canada. (Note 6).

2.1.2 Supply all necessary fasteners, flashings, caulking, wood fixing blocks and bituminous paint required for installation of Cavity Roof Decking in strict accordance with manufacturer's instructions.

2.1.3 Assembly fasteners shall be ....

2.1.4 Holding down fasteners shall be ....

2.1.5 Flashings shall be ....

2.1.6 Caulking shall be non-hardening, non-staining type ....(Note 7).

2.2 APPLICATOR & WORKMANSHIP:

2.2.1 Work shall be carried out by an Atlas Turner Inc. Approved Applicator experienced in this type of work. (Note 8).

2.2.2 Perform work in strict accordance with manufacturer's instructions.

2.2.3 Coordinate work with other trades to assure proper sequence of construction to accommodate skylights, roof drains, flue stacks, waterproofing, flashing, etc.

2.2.4 Exclude work specified under other Divisions and not connected with the application of the material such as supporting frame, flashings to openings, etc. (Describe).

2.3 FLASHINGS:

2.3.1 Install sheet metal, aluminum or stainless steel flashings or other (specify) around skylights, roof drains, flue stacks and other openings, and where indicated or normally required to provide a weathertight installation in accordance with the working drawings and approved shop drawings. (Note 9).

2.3.2 Install flashings in conjunction with the material. Secure adequately with minimum joints.

2.3.3 Coat aluminum surfaces in contact with concrete or masonry with bituminous paint.

2.4 CAULKING:

2.4.1 Joints to be caulked shall be clean, dry and free from oil, grease, snow, ice or any foreign matter impeding adhesion.

2.4.2 Apply caulking in strict accordance with manufacturer's instructions and detail drawings.

6. Specify applicable drawing numbers.

7. Specify brand name and manufacturer.

8. Although any reputable building contractor can apply Cavity Roof Decking, many contractors have specialized in this material.
These contractors have acquired particular skills in handling, erecting and estimating.
Recognizing this experience and approving of their methods, Atlas Turner Inc. recommends these contractors.
Atlas' Approved Applicators are located in most major Canadian and American cities.
For the list in your region, contact any Atlas Offices listed below.

9. If shop drawings are not required delete words "and approved shop drawings".

2.4.3 Except where indicated or specified otherwise, caulking shall be concealed.

2.4.4 Remove excess caulking material from adjacent surfaces.

2.5 EXPANSION JOINTS:

Provide expansion joints as detailed and where indicated on working drawings.

3. GUIDES

3.1 OTHER WORK UNDER THIS DIVISION:

3.1.1 Roof Decking material referred to on drawings as Cavity Roof Decking shall be Atlas asbestos fiber reinforced cement Cavity Roof Decking as manufactured by Atlas Turner Inc., Montreal, Canada. Application of Cavity Roof Decking is specified separately under this Division. Cavity Roof Decking and "T" Deck joints as called for on drawings ____________________ (specify), are covered by the Cavity Roof Specification. (Note 10).

10. Delete this clause if all roof decking called for on drawings is "T" Deck. Refer contractor to Cavity Roof Decking Specification which covers Cavity Roof/"T" Deck joints.

3.1.2 Built-up Roofing - specified elsewhere under Division 7, Moisture Control.

3.1.3 Roof Insulation - specified elsewhere under Division 7, Moisture Control.

3.1.4 Building Insulation - specified elsewhere under Division 7.

3.1.5 Roof Accessories (plastic skylights, gravity ventilators, etc.) - specified elsewhere under Division 7, Moisture Control.

3.2 OTHER WORK UNDER OTHER DIVISIONS:

3.2.1 Acoustical Treatment - specified under Division 9, Finishes.

3.2.2 Fire Resistant Coatings - specified under Division 9, Finishes.

3.2.3 Painting - specified under Division 9, Finishes.

ATLAS TURNER

MONTREAL •
TORONTO •
WINNIPEG •
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DISTRICT SALES OFFICES:
5600 Hochelaga, Montreal, Quebec H1N 1W1/(514) 259-2531/Telex: 05-828769
131 Brown's Line, Toronto, Ont. M8W 3S7/(416) 259-9281/Telex: 06-984512
P.O. Box 3278, Langley, B.C. V3A 4R6/(604) 533-3611/Telex: 04-365535

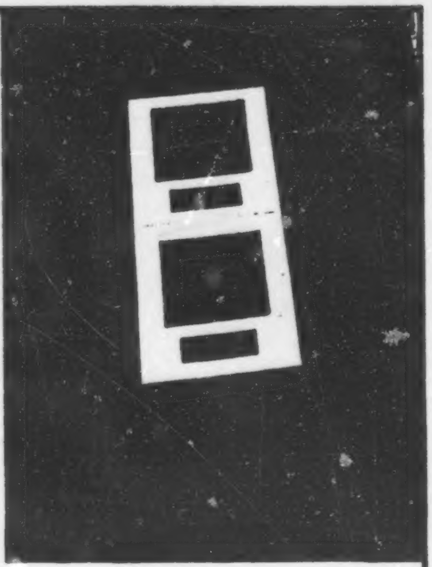
ATLANTIC PROVINCES REPRESENTATIVES:
Guildfords Limited, P.O. Box 416, St. John, N.B. E2L 4L9/(506) 652-8790
Guildfords Limited, P.O. Box 609, Dartmouth, Nova Scotia B2Y 3Z2/(902) 469-9201
Guildfords Limited, P.O. Box 2247, Station 'A', Moncton, N.B. E1C 8J1/(506) 389-3407
Guildfords Limited, P.O. Box 8486, St. Johns, Nfld. A1B 3N9/(709) 368-3114

U.S.A. FACTORY REPRESENTATIVES:
Andy Richardson, P.O. Box 1742, Lancaster, PA. 17604/(717)569-3821
Donald Vagan, 1509 North Berry Road, Rockhill, MO. 63119/(314) 968-4133
Donald R. Stevenson, P.O. Box 3278, Langley, B.C. V3A 4R6/(604) 530-0143
Telex: 04-365535
L. Robert Enslin Jr., 3320 Hollyglen Drive, Marietta G.A. 30062/(404) 977-9033

APPENDIX X

ATLAS PANFAB MATERIAL

Unique architectural custom moulded wall systems in fibro-ciment from PANFAB



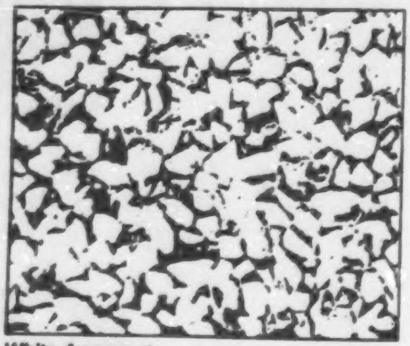
PANFAB

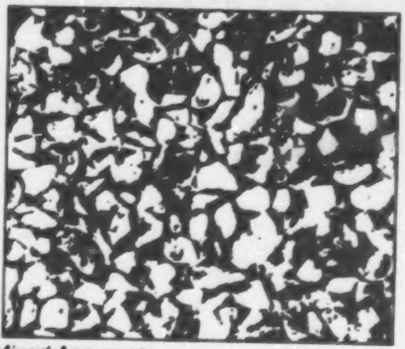
A subsidiary of ATLAS TURNER INC.

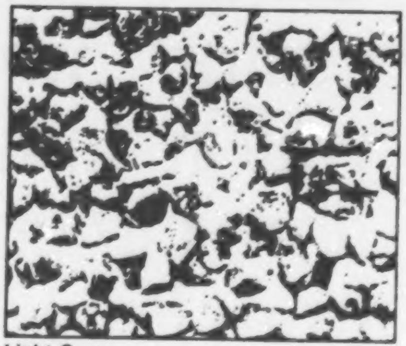
Tél.: (514) 674-4905 Telex: 05-828875

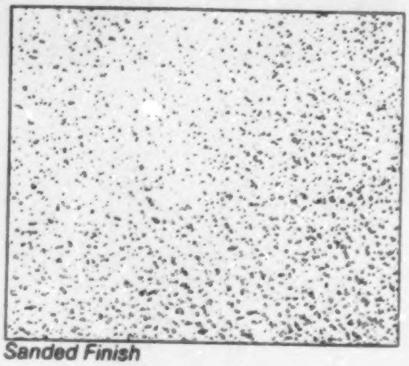
Ramada Inn
Niagara Falls
Ontario

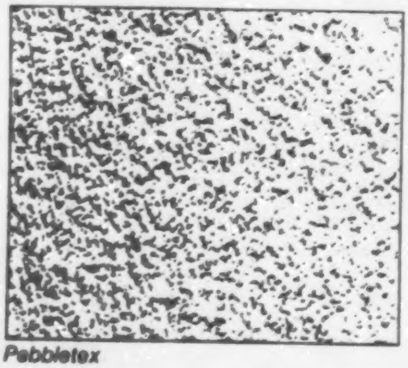
architectural finishes

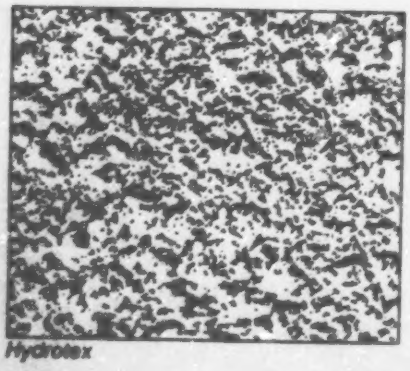

White Aggregate


Mixed Aggregate


Light Green


Sanded Finish


Pebbletex


Hydrotex

Panfab architectural veneers for interior or exterior use provide the architect and designer with a virtually unlimited selection of color and texture for flat and sculptured surfaces. The mating of fiber reinforced cement substrate with a wide range of finishes has proven to be an efficient, dependable, and long lasting system.

Textures can be precisely controlled due to in-plant manufacture under known environmental conditions thus allowing custom textures to be developed to meet particular design requirements. Panfab architectural finishes will not support combustion. This fact combined with a 0-0-0 rating for the fiber reinforced cement substrate provides a completely incombustible veneer system. Panfab veneers are completely resistant to ultraviolet attack and possess a coefficient of expansion and contraction which is common with cement and masonry surfaces.

The durability of all Panfab veneers is further enhanced by the addition of an acrylic glaze as a final, scrubbable, protective coating. This coating offers a high degree of resistance to fading and deterioration from weather, dust, dirt, ultraviolet, industrial pollutants, alkalis, salts, and other airborn chemicals.

Water penetration is prevented without creating a vapour barrier, so as to permit a breathing system. Permeability is reduced to 2.4 perms, providing superior weatherproofing. The veneers are more durable and stable than other conventional types of panel systems.

They are attached to wood or metal furing by colored fasteners, mouldings or hidden clips. Panels are supplied in standard sizes of 4' x 8', 4' x 10', and 4' x 12' however non-standard sizes are available on request.

EXPOSED AGGREGATE:

Panfab exposed aggregate panels are composed of a fiber reinforced cement substrate coated with a specially formulated matrix of acrylic polymers, graded silica sand, fine mineral aggregates and portland cement. Exposed natural stone is embedded in the matrix to give a highly durable finish and a striking effect. Standard aggregate sizes are #1 (⅛" to 3/16" stone) and #2 (¼" to ⅜" stone). An extremely wide range of aggregate colors is available embedded in a virtually unlimited range of matrix tones.

SANDED FINISH:

The beauty and simplicity of Panfab's sand finished panels give any building a look of quality at a modest price. Panels are manufactured of silica sand and acrylic polymer emulsions bonded to a fiber reinforced cement substrate. The aesthetic and physical characteristics of Panfab sanded panels make them an excellent choice in contemporary curtain-wall design, especially in structures where high fire resistance is required.

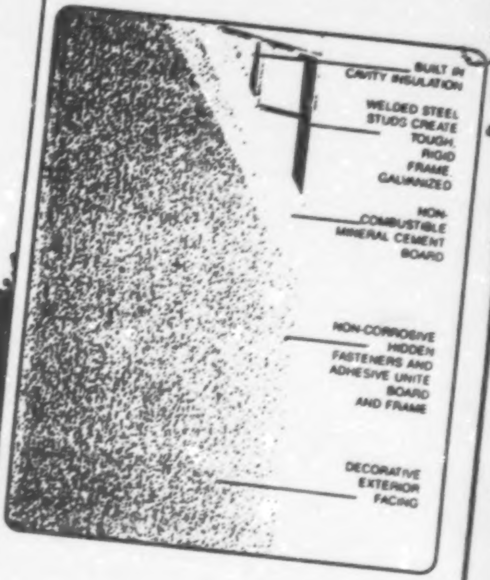
PEBBLETEX:

The aesthetic quality of Panfab Pebbletex lends the substantial feel of hand-crafted masonry to any architectural style. Panfab Pebbletex is manufactured of portland cement, silica sand, and silica pebbles, combined with special blends of acrylic polymer emulsions bonded to a fiber reinforced cement substrate. Panfab Pebbletex can be supplied in coarse, medium or fine textures.

HYDROTEX

Panfab Hydrotex is an acrylic based copolymer coating on a fiber reinforced cement substrate which will not peel or flake. Hydrotex is available in the regular stucco-type finish as shown in the photograph or in the "antique" finish which gives a trowelled or flattened appearance. Variations of these finishes can be achieved to suit special requirements. Panfab Hydrotex is available in an unlimited range of colors and provides the designer with a highly durable product which outlasts any conventional stucco system.

composite wall systems


BUILT IN CAVITY INSULATION
WELDED STEEL STUDS CREATE TOUGH, RIGID FRAME, GALVANIZED
NON-COMBUSTIBLE MINERAL CEMENT BOARD
NON-CORROSIVE HIDDEN FASTENERS AND ADHESIVE UNITE BOARD AND FRAME
DECORATIVE EXTERIOR FACING

DURACELL, NEEDHAM, MSS., USA.

PANFAB prefabricated panels offer great design versatility by combining welded structural steel stud frames with rigid fiber reinforced cement board and a wide range of exterior surfacings to create durable lightweight components

Custom shaped contours are readily fabricated for fascias, spandrels, window surrounds, column covers and other exterior areas. An extensive range of aggregate, textured or sanded finishes is available to meet any aesthetic requirements

PANFAB units are non-combustible, offer excellent insulating values and qualify for use in Class A structures. They weigh *less than ten pounds per square foot* and can be installed without heavy construction equipment so erection time and costs are minimized

Our Engineering staff will furnish engineering data, suggested details and quotations for any project

DESIGN AND FABRICATION

PANFAB components are fabricated using wide-flange steel studs exceeding the requirements of ASTM A570-66T.

PANFAB stud framing members are welded together to insure maximum component rigidity. Fiber reinforced cement board is then laminated to the exterior flange of the structural frame using a combination of non-corrosive screws and special adhesive. The result is a strong composite unit to which a selected aggregate, textured, or sculptured surfacing is applied

PANFAB studs are usually spaced at 16" o c and the stud cavity can be filled with friction-fit fiberglass building insulation to obtain a U-factor of .08 or less. The interior flange of the PANFAB prefabricated panel frame creates a solid support for screw-attaching interior gypsumboard at the job site to complete the total wall assembly. Panels are also constructed using special truss-type studs to eliminate potential thermal bridges in insulated panels.

The cut-away photo above shows the construction of a typical PANFAB wall panel

The graphs shown below indicate the allowable spans for flat PANFAB components using wide flange studs of varying depths. The data shown relates to simple span conditions for a PANFAB unit, fabricated from 16-gauge studs at 16" o c with deflection limitation of L/240 and L/360

Where other stud sizes, gauges or spacings are used or unusual design conditions apply, our Engineering Department will furnish specific windload calculations and data on request

INSULATING VALUES

An analysis of the thermal resistance values of PANFAB assemblies using 3½" and 6" thick insulation is indicated here, along with the "U" values obtained by the completed system

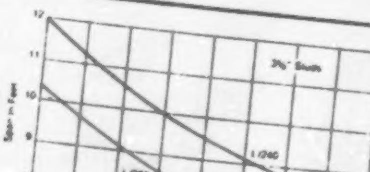
"R" AND "U" VALUE CALCULATIONS

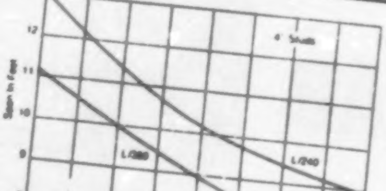
Components	"R" Values	
	4" Studs	6" Studs
fo (outside 15 mph wind)	.17	.17
¼" fibre cement board	.21	.21
Insulation	13.00	19.00
½" gypsum board	.45	.45
fi (inside still air)	.68	.68
TOTAL RESISTANCE = R_t =	14.51	20.51
"U" FACTOR = $1/R_t$ =	.07	.05

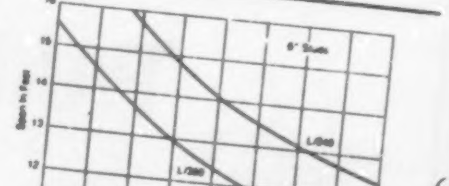
FIRE RESISTANCE

PANFAB components are manufactured entirely from non-combustible materials. Fiber reinforced cement board used on the exterior face has zero flame spread and smoke density ratings. All PANFAB surfacing materials are portland cement-based with flame spread and smoke density ratings varying from 0 to 5, depending on the finish selected. Where PANFAB units are preinsulated at our plant, we use inorganic inert insulation which carries a non-combustible rating

After PANFAB units have been installed at the job site, fire rated gypsum wall board is usually anchored to the interior flange of the PANFAB frame to complete the exterior wall. This assembly qualifies as a one-hour fire rated system under most building codes







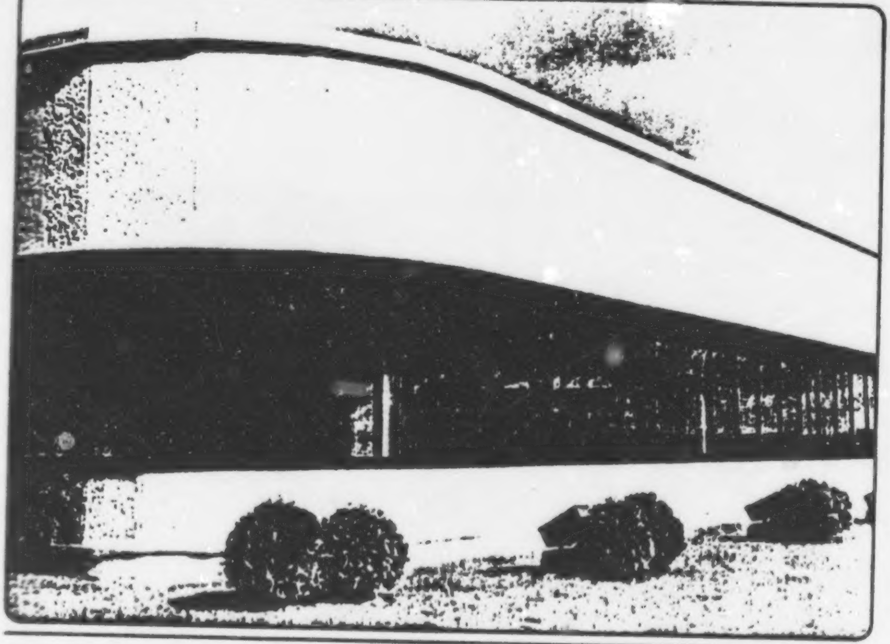
sandwich panels

Panfab Sandwich Panels are high quality multipurpose panels composed of two equal thickness fiber reinforced cement sheets laminated to an insulating core. An architectural coating applied to the external face of the Panfab Sandwich Panel results in a panel of high thermal efficiency, as well as unparalleled beauty, economy, strength, and durability. Panfab Sandwich Panels are ideally suited as infill panels between windows or for use with curtain wall systems. Standard cores consist of expanded polystyrene or urethane where maximum insulation value is required. Phenolic foam, expanded permalite board, or foamed glass cores are also used to meet requirements for incombustible construction. These cores provide a lower thermal resistance.

Panfab Sandwich Panels can be installed quickly and easily without heavy equipment thus reducing onsite installation costs. Various joint details are available to meet the particular requirements of the project.

Panfab Sandwich Panels have a high strength-to-weight ratio. They are dimensionally stable, permanently flat, extremely resistant to impact and abrasion, and possess low sound transmission characteristics.

All our Architectural Finishes can be applied to the outside face of Panfab Sandwich panels. In addition panels are also available with a polyurethane coating which provides a very hard glossy surface.



TRANSCANADA SHOES, CHOMEDEY, QUÉBEC.

KEVLEE TOWERS, OTTAWA, ONTARIO.

PANFAB

2435 de La Province
Longueuil, Québec,
J4G 1G2
(514) 674-4905/6

APPENDIX XI

U.S. MARKET DATA ON BOARD PRODUCTS

1. PARTICLEBOARDS & SHEET MATERIALS.

1.1. Waferboard.

There is no significant sale of this type of material in the U.K. so no further information is worthy of inclusion in this report.

1.2. Aspen Board.

There is no significant sale of this type of material in the U.K. so no further information is worthy of inclusion in this report.

1.3. Chipboard.(Conventional Particleboard).

Chipboard is produced in the U.K. and also imported from a variety of sources including Western and Eastern Europe.

1.4. O.S.B. (Oriented Strand Board).

One plant has recently come on stream in the U.K. As yet there is no significant volume of imports.

1.5. Plaster Board.

The market is supplied from U.K. production facilities but from time to time the material has been imported from overseas including Canada.

1.6. Cement Bonded Particle Board. (Portland and Magnesite Cement).

At the time of preparing this report material based on Portland Cement is imported from Western Germany, France and Turkey. A new plant is planned to be on stream in the U.K. during February 1988. Magnesite based board is imported from Finland in very small quantities.

1.7. Gypsum Bonded Particleboard.

As yet there is no significant sale of this material in the U.K. nor at the time of preparing this report is there any indication of any intention to set up production in the U.K. There is therefore no reliable information on the likely price structure although it probable that the ex-works price will be below that of Cement Bonded Particleboard whether a new plant is introduced or, as is understood to be under consideration, an existing Chipboard plant is converted for this purpose. No further details can usefully be included in this report.

1.8. Plywood.

The market is supplied almost entirely by imports from various parts of the world including Europe, Canada and South East Asia. From the great variety of types that are available in the U.K. a short selection has been made which has relevance to the study.

1.9. Fire Resistant Flat Sheet Materials. (Asbestos free).

The markets for this type of board are presently dominated by a range of products manufactured in the U.K. by Cape Boards and Panels Ltd. The range includes 'Masterclad'; 'Masterboard'; 'Supalux' and 'Monolux'. The boards are described as being of laminar structure and consist of a calcium silicate matrix reinforced with selected fibres and fillers. (The fibres are in fact cellulose).

These boards are of particluar importance relative to Cement and Gypsum Bonded Particleboards as in the U.K. they represent the major competition. Overall their performance is comparable to Cement and Gypsum Bonded Particleboards and they are offered in a range of thicknesses which whilst not as comprehensive do serve major market segments.

1.10. Other Fire Resistant Boards.

There are a number of other boards available in the U.K. which are only marginal competitors to Cement and Gypsum Bonded Particleboard and will not be dealt with in detail. However because of an overlap in uses they do need to be mentioned. These products originate from several organisations including the U.K. operation of Eternit (Belgium) which recently took over the board production side of Turners. The Turners range is similar to that of Cape but has made little market penetration. Eternit are also offering their own range but as yet have not made any headway.

For the fire protection of steel frame buildings there are several boards available based on Vermiculte including a product from Cape. This is a small but growing market as in the U.K. steel is gradually increasing its market share against reinforced concrete frame.

1.11. M.D.F. (Medium Density Fibreboard).

This type of board has been produced for many years in the U.K. under the description of Medium Hardboard. The latest version of the product, now called M.D.F. is a smoother, finer fibre board produced on a more modern plant than previously. It is imported from Europe and there is also an availability in the U,K, The market has grown rapidly in recent years and it is reported that additional production will soon be on stream in the U.K. However taking Europe overall there are indications of over production.

2 PRICE STRUCTURE IN THE U.K. BY TYPE.

A) In almost every category of board dealt with in this report a large proportion of the market is serviced by imports. Because of the variety of sources, extreme competition and variations in rates of exchange it is only possible to base the Distributors price on an approximate average and on the general situation at the time the report was issued.

B) It must also be borne in mind that most Distributors publish a price list which is issued to the End User (Trade & Public) and in effect is structured on a quantity discount basis. Such price lists tend to remain effective for up to a twelve month period. Therefore in the case of imports the margin enjoyed by Distributors on their selling price can fluctuate quite widely.

C) In the U.K. prices are usually quoted per board or per square metre. However because of the wide variety of boards dealt with herein and the different thicknesses involved a decision has been taken to convert all products into a rounded price per Cubic Metre. This will enable a more immediate comparison to be made and is also more relevant to production costs.

D) When large contracts or orders are on offer extreme pressure is exerted by buyers upon Distributors/Merchants to reduce prices and so price lists are inoperative. The problem is exacerbated by Importers/Shippers and indigenous manufacturers who are keen to increase turnover in a situation where price rather than quality or performance is the deciding factor. In such circumstances margins are squeezed but having acknowledged this the information contained in this report can still be regarded as a fair and reasonabble guide to the normal situation in the U.K. market

2.1. Chipboard.

This product is available in various grades including:- Standard; Flooring; Moisture Resistant and Flame Retardant.

2.1.1. Standard Grade.

Thicknesses(mm):- 6,9.12,15,18,22,25,30,38. (plus others)

Sizes(mm):- 1220 x 2440, 1220 x 3050. (plus others)

Buying price for major Distributor:-

£90. upwards per cubic metre.

End user price for purchases of 50 boards:-

£120. to £150+ per cubic metre.

2.1.2. Flooring Grade.

Thicknesses(mm):- 18 & 22.

Sizes(mm):- 1220 x 2440 & 600 x 2440.

Buying price for major Distributor:-

£115. per cubic metre.

End user price for purchases of 50 boards:-

£150. per cubic metre.

2.1.3. Moisture Resistant Grade.

Thicknesses(mm):- 12,18,22,25,30,38.

Sizes(mm):- 1220 x 2440 & 1220 x 3050.

Buying price for major Distributor:-

£155. per cubic metre.

End user price for purchases of 50 boards:-

£205. per cubic metre.

2.1.4. Flame Retardant Grade.

Thicknesses(mm):- 10,12,16,18,25.

Sizes(mm):- 1250 x 3050.

Buying price for major Distributor:-

£215. per cubic metre.

End user price for purchases of 50 boards:-

£285. per cubic metre.

2.2. O.S.B.

Thicknesses(mm):- 6,8,9,11,15,18,22,25.

Sizes(mm):- 1220 x 2440.

Buying price for major Distributor:-

£150. upwards per cubic metre.

End user price for 46 boards (6mm) to 10 boards (25mm):-

£188. (18mm) to £234. (6mm) per cubic metre.

2.3. Plaster Board.

Thicknesses(mm):- 9.5 & 12.5.

Sizes(mm):- 900 x 1829, 1200 x 2438, 1200 x 3000.

Buying price for major Distributor:-

£100. per cubic metre.

End user price for 100 boards:-

£115 to £125. per cubic metre.

2.4. Cement Bonded Particleboard.

A) For the past six years or so, and until quite recently, a Portland Cement based board (Trade Mark 'Duripanel'), produced in West Germany, has been the only product of its type on offer and the Importers pricing strategy has been based on the assumption that the main competition is represented by the Cape range. Therfore the price has been set to be competitive with the Cape range but with the advantage of allowing the Distributor much greater margins than are normal with all other Particleboards and Sheet materials. In other words the price has been set by the market and not on a production cost basis.

Until recently this policy has been justified and viable but in recent months similar boards have been imported at cut prices and this coupled with production from the new plant in the U.K. is likely to lead to pressure on margins and published prices..

Because of the price changes that are taking place this section of the report will endeavour to cover the situation in as much detail as possible.

2.4.1. Thicknesses(mm):- 6,8,10,12,16,18,20,24,28,32,40.

Sizes(mm):- 1250 x 2600/3100.

Unsanded finish. (A sanded board is also available at extra cost)

2.4.2. The price paid by the importer is £350. per cubic metre delivered to U.K. warehouse.

New boards now available from Turkey etc, are being offered at under £300. per cubic metre delivered U.K. warehouse.

2.4.3. Based on the original cost of imported board which was less than £300. per cubic metre delivered U.K. warehouse the price structure has been as follows:-

Recommended Trade price:-

£800. per cubic metre for orders of 1 board or more.

Processor/Fabricator price:-

£475 to £525. per cubic metre depending on quantity.

Distributor/Stockist price:-

£720. per cubic metre - from which the following discounts were allowed:-

1-4 pallets - less 15%, less 10%, less 5% = £523.

5-8 pallets - less 15%, less 10%, less 10% = £495.

9+ pallets - less 15%, less 10%, less 10%, less 5% = £470.

This price structure leaves a gross margin to the importer (or manufacturer whose production cost should be less than £300. per cubic metre) of around £150. per cubic metre after stocking, handling and delivery cost from warehouse to Stockist.

2.4.4 Put another way, in the U.K. there would appear to be ample room for a reduction in price to the End User and the margin presently enjoyed by the Distributor should such a decision be likely to increase the potential. This may well happen in the near future because of the necessity to to increase market share which has been slow to develope due largely to lack of a concentrated and sustained level of sales activity.

2.4.5. Magnesite cement based board is also available in the U.K. but due to it's application limitations; it is only suitable for internal use; it has not achieved significant sales and it is the type of material that could well be overtaken by Gypsum Bonded Particleboards. Much will depend on price/performance comparison but for the moment neither product has any status in the market.

Apart from the limitation to internal use Magnesite is avaible to a specification and price similar to that of the Portland Cement based board.

2.5. Plywood.

Such is the variety of types, sources, sizes, thicknesses, finishes, etc., etc,. that it is only possible to give an indication of prices from a short selection which is considered relevant to this report.

2.5.1. Commercial Grade, Birch Faced.

Thicknesses(mm):- 1.5 to 24.

Sizes(mm):- 1220 x 2440/3050 1525 x 1525/3050/3660.

Buying price for major Distributor:-

£400 to £500. per cubic metre.

End user price for 60 boards:-

£515 to £615. per cubic metre.

2.5.2. Sheathing Grade, American/Canadian.

Thicknesses(mm):- 9.5, 12.5, 19.

Sizes(mm):- 2440 x 1220.

Buying price for major Distributor:-

£150 to £185. per cubic metre.

End user price for 60 boards:-

£185 to £250. per cubic metre.

2.5.3. Flame Retardant Commercial Grade.

Thicknesses(mm):- 3,4,6,9,12,18,25.

Sizes(mm):- 1220 x 2440/2750/3050.

Buying price for major Distributor:-

£400 to £575. per cubic metre.

End user price for 60 boards:-

£500 to £725. per cubic metre.

2.6. Fire Resistant Flat Sheet Materials.

The only materials that need to be considered under this heading are those available from Cape Boards & Panels Ltd. The details are as follow:-

2.6.1. Masterclad

Suitable for internal and external use.

U.K. Fire rating Class 0; BS 476.

Thicknesses(mm):- 4.5,6,9.

Sizes(mm):- 2400 x 1200.

End user price £707. per cubic metre for 50 boards.

Best Distributor price is £707. per cubic metre -

less 15%, less 10%, less 5% =

£514, per cubic metre.

2.6.2. Masterboard

Primarily for but not limited to internal use.

U.K. Fire rating Class 0; BS 476.

Thicknesses(mm):- 6,9,12.

Sizes(mm):- 2400 x 1200.

End user price:-

6 mm = £639. per cubic metre for 50 boards.

9 mm = £789. per cubic metre for 50 boards.

12 mm = £780. per cubic metre for 50 boards.

Best Distributor price is:-

6 mm = £639 less 15%, 10%, 5% = £464.

9 mm = £789 less 15%, 10%, 5% = £573.

12 mm = £780 less 15%, 10%, 5% = £567.

2.6.3. Supalux

Primarily for but not limited to internal use.

U.K. Fire rating Class 0 & Non-combustible, BS 476.

Thicknesses(mm):- 6,9,12.

Sizes(mm):- 2400 x 1200.

Also available with Sanded Face at extra cost.

End user price:-

£780 to £805. per cubic metre for 20 boards.

Best Distributor price is £780/805.per cubic metre - less 15%, 10%, 5% =

£567/585. per cubic metre.

2.6.4. Monolux 40

Used for insulating Ovens, Dryers and Tanks; for Oven shelving and interleaves, heat breaks, gaskets, insulated pipe supports, high temperature ducts and trunking.etc.

U.K. Fire rating Class 0 & Non-combustible, BS 476

Thicknesses(mm):- 12,16,19,22,25,32.

Sizes(mm):- 1200 x 2400/2700/3000 & 1220 x 2440/2745/3050

End User price:-

12 mm = £1258. per cubic metre for 10 boards.

19 mm = £1010. per cubic metre for 10 boards.

25 mm = £920. per cubic metre for 10 boards.

Best Distributor price is:-

12 mm = £1258 less 15%, 10%, 5% = £934 per cubic metre.

19 mm = £1010 less 15%, 10%, 5% = £734 per cubic metre.

25 mm = £920 less 15%, 10%, 5% = £668 per cubic metre.

N.B. The above figures are accurate within reasonable limits but there is evidence that the supplier offers special customers extra inducements against a target volume - perhaps around 5% backfiring discount.

2.7. Other Fire Resistant Boards.

There are a number of materials available on the U.K. market which seem to find a limited acceptance for specialised uses but a detailed analysis would contribute little to the objective of this report. Nevertheless it is important to have an indication of the sort of product that is available and the best example is another Cape product used for the fire protection of structural steel marketed under the name of 'Vermiculux'

2.7.1. Vermiculux

Thicknesses(mm):- 20,25,30.

Sizes(mm):- 1220 x 610.

End user price:-

£440 to £485. per cubic metre for 50 boards.

Best Distributor price is:-

£440/£485 = less 15%, 10%, 5% = £320/£352 per cubic metre.

2.8. M.D.F.

2.8.1. M.D.F.

Thicknesses(mm):- 6,8,9,10,12,14.5,15,16,17.5,18,19,22,25,
30,32.

Sizes(mm):- 1220 x 1830/2440/2745/2750/3050.

End user price:-

With the exception of 6 mm; for which a premium of some £50+ per cubic metre is required; prices fall within the £250 to £300. per cubic metre rangefor 50 boards.

Best Distributor price is:-

£195+ range per cubic metre.

2.8.2. Medium Hardboard

'A' quality is for general use and 'K' quality is for internal use only.

'A' quality.

Thicknesses(mm):- 6.4,9.6,12.7.

Sizes(mm):- 2440 x 1067/1220.

End user price:-

In the £535/575 range per cubic metre for 50 boards.

Best Distributor price is:-

£375/400 range per cubic metre

'K' quality.

Thicknesses(mm):- 6.4,9.6.

Sizes(mm):- 2440 x 1067/1220/

End user price:-

In the £450/£500 range per cubic metre for 50 boards.

Best Distributor price is:-

£320/350 range per cubic metre.

3. STATISTICS & APPLICATIONS.

3.1. Chipboard.

3.1.1. Statistics

In the year ending December 1986 the total U.K. consumption was 2,368,110 square metres. Figures for the whole of 1987 are not yet available but comparing the first six months of 1986 with the same period in 1987 there is an increase in demand of 6%.

Imports supply about 60% of the market with the balance coming from home producers.

3.1.2. Applications

Chipboard is an extremely versatile product and it would be difficult to try and list all its possible uses. In the U.K. market it has substantial sales into the following market sectors:-

a) Furniture.
b) Flooring.
c) Partitioning.
d) Roof Decking.
e) Pre-fabricated Structures.

3.2. O.S.B.

3.2.1. Statistics.

The plant in the U.K. has only recently come on stream and as yet there are no reliable figures for production or sales. The only information that has emerged is that not surprisingly the plant is only running on a limited shift basis while an effort is made to build up a profitable market share.

The investment was made on the assumption that there would be a substantial market for O.S.B. to be used as Sheathing in Timber Frame Housing. Unfortunately during the period when the plant was being errected the market for timber frame collapsed from a 25%+ share of the total U.K. housing market to near 5% due to a very critical TV programme. Over the past three years there has been a slow recovery to a 10% share and the trend continues but it is very doubtful if it will ever claw back all of the lost ground.

However even at 10% there is a market of somewhere near 2,000,000. square metres per annum and this would be a large percentage of the plant output.

3.2.2. Applications.

As already stated the main market for O.S.B. in the U.K. is likely to be in Timber Frame Houssing. In the U.K. this type of construction uses an outer wall of 4½ inch brickwork, a cavity of 2 inches and a timber frame inner wall which is lined with Plasterboard on the inside and with a sheathing on the 'outside'.

Prior to the introduction of O.S.B. over 90% of the market was supplied by Plywood.

O.S.B. is seen as a competitor to plwood rather than to other sheet materials so it has a vast range of outlets too numerous to list in this report.

3.3. **Plaster Board.**

3.3.1. Statistics.

This product has an annual sale in the U.K. of around 100,000,000. square metres or very approximately 1,000,000. cubic metres.

3.3.2. The major uses for this product are ceilings and dry wall lining in housing as well as partitioning in all types of structures. It enjoys an almost total monopoly of the wall and ceiling market in housing.

3.4. Cement Bonded Particleboard.

3.4.1. Statistics.

Due to the lack of sustained effort the market has not developed as well as might have been expected. Certainly the product has the potential, indeed the range of potential applications is in some ways a drawback and has led to a failure to concetrate on the most suitable market segments. As a result sales have not as yet risen above a rate of 5000 cubic metres per annum but market research suggests there could well be a total market in excess of 25,000 cubic metres per annum. To achieve this will require a greater effort than has been made in the past and as the new plant has an initial capacity of 18,000 cubic metres per annum it can be anticipated that the necessary commitment will now be made.

3.4.2. Applications.

This product is so versatile it can to a lesser or greater degree penetrate the markets of all other sheet meterials. The list that follows is a selection of the main markets in the U.K. that have been or can be penetrated:-

a) Flat Roof Decking.
b) Partitioning.
c) Sheathing.
d) Ceilings
e) Fire Resistant Doors.
f) General Fire Protection.
g) Flooring.
h) External Cladding.
i) Tunnel Lining.
j) Fire Resistant substrates for Laminates etc.

3.5. Plywood.

3.5.1. Statistics.

Figures provided by U.K. Government sources indicate that imports have for the past few years been running at around £125,000,000. per annum. This figure is not easily converted into volume due to the vast range of prices and thiccknesses but it is likely to be in the order of 500,000. cubic metres a year.

3.5.2. Applications.

Despite the increasing range of particleboards that have been introduced over the past 40 years Plywood still retains a very substantial market and its uses are so well known that it is not felt necessary to list them in this report.

3.6. Fire Resistant Flat Sheet Materials.

3.6.1. Statistics.

This market is largely served by Cape but due to the changes in supply that have taken place over recent months it is not possible to obtain very accurate information on sales levels. However based on past data it is estimated consumption is near to 100,000. cubic metres per annum.

3.6.2. Applications.

In the past 35 years since this type of product was introduced the Cape organisation has built up a pre-eminent position in providing fire resistant flat sheet materials to all possible applications in all types of industry.

The main uses for the products are ceilings and walling/lining/partitioning in industrial and commercial property and in particular stores and supermarkets.

Any situation where a flat sheet material is needed which will also contribute towards fire resistance is a market for this range of products.

Potential applications for Monolux have been given in Para 2.6.4. of this report

In some instances the application is not ideal but failing the availability of a more suitable alternative and because of the excellent technical back-up the range of products has been very well received by all the usual specifying and buying influences and a strong brand loyalty now exists.

3.7. Other Firs Resistant Boards.

3.7.1. Statistics and Applications.

It is not possible in a report of this kind to cover all the possibilities that exist for fire resistant sheet materials. In any event the major markets have been dealt with under 3.6. There is nevertheless one worthwhile and growing market that is supplied by boards which are specifically produced to meet the performance requirements of this sector. It is the fire protection of structural steel frames which in the U.K. are gradually overtaking the use of reinforced concrete frames much in favour in the post war building boom.

The steel share of the market is in excess of 30% which converts to a board consumption of some 16,000. cubic metres per annum.

3.8. M.D.F.

3.8.1. Statistics and Applications.

This type of product is a relatively new entrant to the U.K. and so there are no adequate figures available for consumption. The main thrust is into the furniture market but it is a competively priced product and it is inevitably finding acceptance in other sectors where its particular charateristics give it an advantage over the entrenched opposition.